

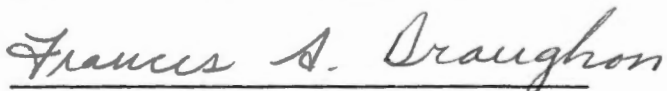
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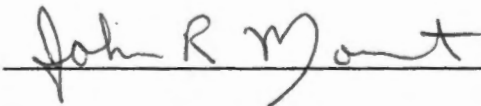
I am submitting herewith a dissertation written by Ignatius U. Manu entitled "Chemical, Physical and Sensory Attributes of Chips Prepared with Sweet Potato Flour." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Food Technology and Science.

  
\_\_\_\_\_  
Dr. J. L. Collins, Major Professor

We have read this dissertation  
and recommend its acceptance:

  
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Accepted for the Council:

  
\_\_\_\_\_  
Vice Provost and Dean of  
the Graduate School

**CHEMICAL, PHYSICAL AND SENSORY ATTRIBUTES  
OF CHIPS PREPARED WITH  
SWEET POTATO FLOUR**

**A Dissertation  
Presented for the  
Doctor of Philosophy  
Degree**

**The University of Tennessee, Knoxville**

**Ignatius U. Manu**

**August 1991**

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THESIS

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## **DEDICATION**

**This dissertation is dedicated to my parents Vincent and Theresa Manu and my brothers and sisters for their support, love and understanding.**



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## ABSTRACT

The objectives of this research were to develop chips from flour of sweet potato flesh (FSPF) or skin (epidermis) (FSPS) and white potato and to measure chemical, physical and sensory attributes of the chips.

Sweet potato (Ipomoea batatas, Lam) (SP) roots of orange flesh, red skin and a moist-type unknown cultivar were cut into 1.2 cm slices, immersed in 0.25% citric acid solution, heated in an atmospheric pressure blancher, pureed and dried with a double drum-dryer. FSPF and FSPS were produced separately. Individual SPF at levels of 25, 50, 75 and 100% of the amount of white potato flour were mixed together to produce flakes. Ingredients used in dough formulation included water, butylated hydroxyanisole and salt (used in one-half of the chips). A smooth sheath of dough of 0.1 mm thick was cut into circular pieces of 3.8 mm diameter and fried in oil. Chips were salted or unsalted, flushed with nitrogen gas or stored in air for 0, 2, 6 and 9 weeks and analyzed for beta-carotene, peroxide value (PV), color and firmness at each period of storage. Proximate composition, gross energy and mineral contents of unsalted chips were analyzed on the same day chips were produced. Salted and unsalted chips for sensory analysis were evaluated for color, texture and overall acceptability after storage of 9 weeks.

Crude fat content of chips with FSPF increased from 25 to 50% while chips with FSPS contained the greatest crude fat content at 100%. Dietary fiber tended to increase in chips with increased levels of SPF. As levels of SPF increased, retinol equivalents (RE) and PV of chips with FSPF or FSPS increased also. Chips of both SPF flushed with nitrogen gas gave greater RE and lower PV than chips held under air atmosphere. Salting the chips reduced RE and PV. RE of chips with FSPF decreased by 11.93% from 0 to 9 weeks storage while chips with FSPS decreased 5.97%. After 9 weeks storage, chips with FSPF yielded PV of 18.08 meg/kg fat as opposed to PV of 4.23 meg/kg fat for chips analyzed on the day of production.

Chips became firmer as the level of SPF increased. Salt, gaseous atmosphere and storage periods had little or no effect on firmness of chips. Hunter L values (lightness) of chips decreased and Hunter 'a' values (redness) and Hunter 'b' values (yellowness) increased as level of SPF increased. Nitrogen gas atmosphere of the package under which the chips were stored caused a reduction of the chip color. With extended storage, chips became lighter, and less red and yellow.

All chips prepared with 25 and 50% SPF were preferred by panelists. Generally, salted chips flushed with nitrogen gas were preferred over unsalted chips held under air atmosphere.

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## CHAPTER I

### INTRODUCTION

Sweet potato (*Ipomoea batatas*, Lam) (SP) is an underutilized crop in parts of the world today. This fact may be attributable to its sweetness, problems of discoloration and low socioeconomic status. Increased availability of new or improved consumer SP products could result in increased consumption. Efforts have been made to develop products with SP, including frozen products, chips (Bozorgmehr, 1987; Collins et al., 1976; Hoover and Miller, 1954, 1973; Kelley and Baum, 1955; Kelley et al., 1958; ) and flour, yogurt and fruit leather (Collins and Aziz, 1982; Collins and Washam-Hutsell, 1987; Ebah, 1988).

The higher level of reducing sugars (2%) of SP compared to a lower level (approximately 0.5%) of reducing sugars in white potato used for chips (acceptable sugar level is below 0.5%) is one of the reasons for the lack of popularity of SP for chip production (Hoover and Harmon, 1967). Chips were produced herein from flour prepared from SP and white potato. Use of a mixture of SP flour and white potato flour may be a logical approach to produce an acceptable chip product.

Processed SP is consumed mostly in the canned form as small whole roots or mashed while fresh SP is consumed as

dishes of baked or boiled roots. Flour of SP was evaluated as an ingredient for 2 food products by Gurkin (1988).

SP contains approximately 20% starch, 20-30 mg/100g vitamin C, 0-8000 IU/100g of pro-vitamin A carotenoid (beta-carotene) and an amino acid chemical score of 80 (Huang, 1982). With all these "pros" and because of its abundance, it seems desirable to increase utilization of SP for human consumption.

The objectives of this study were to develop chips from flours of flesh or skin of SP and white potato and to measure some chemical, physical and sensory attributes of the chips.

## CHAPTER II

### LITERATURE REVIEW

#### A. Sweet Potato - General

Sweet potato (Ipomoea batatas, Lam) (SP) is an important crop in many parts of the world especially in the developing countries. The SP originated in Central America and spread to Mexico, South America, North America and Europe (Crosby, 1963;). The Portuguese explorers introduced SP to Africa (O'Brien, 1972) and the English colonists brought roots to the United States in 1650 (Crosby, 1963; Kane, 1978; Miller, 1977).

Consumption level of SP in the United States is very low, compared to other parts of the world. When per capita income is considered, 56% of the world population lives in countries having an average yearly income of less than \$5,090. All, except 6, of these 62 countries are in the tropics and all but 1 are located between 30°N and 30°S latitudes. Thus, SP plays an important role in tropical agriculture (Bouwkamp, 1985). In 1962, SP ranked seventh of all vegetables by weight in per capita consumption in the United States. Since first being introduced in the Southern United States in 1648, popularity of SP has increased to an even greater extent than in other parts of the country. The

reasons for popularity of SP in these countries are mostly due to food shortage and to its inexpensive cost.

Many varieties of SP exist today for food usage although the major use is for cattle feed. At one time, the 2 major cultivars used for food were Puerto Rico and Jersey; other cultivars included Nancy Hall, Red Nancy, All Gold and Rols. Presently, Centennial and Jewel cultivars may be the most widely used cultivar of SP (Bouwkamp, 1985). There are 2 general types of SP: the moist-type with a soft gelatinous flesh and the dry-type with a mealy yellow flesh (Edmond and Ammerman, 1971; Farris, 1978; Marthia, 1975). The moist-type has higher sugar level than the dry-type. In the United States, the moist-type is bright orange color and is referred to as "yams." The true yam is known outside the United States as Dioscorea alata (Fitzgerald, 1976; Kane, 1978; Kushman, 1967; Miller, 1977). The true yam has no botanical relationship to SP (Crosby, 1963). People of the Caribbean region prefer the dry-type while many people of the United States prefer the moist-type (Martin and Rhodes, 1984).

The SP belongs to a relatively large and distinct group of spormatophytes called dicots or dicotyledonous plants. Within the dicot group the SP belongs to the family called convolvulaceae. This family is important economically in the United States; Ipomoea batatas or SP is grown commercially (Lawrence, 1951).



## B. Sweet Potato Products

A variety of products have been made from SP. However, only few of these products have been accepted by consumers. The list of products include SP flakes, patties, chips, pie, canned SP and yogurt with SP (Collins et al., 1976; Collins et al, 1983; Ebah, 1988; Hoover, 1967; Hoover et al., 1983) There is no doubt that increased development of appealing processed products of SP will expand its utilization. Of the products made from SP, only baby food can be considered a commercial success (Bouwkamp, 1985). Canned SP is widely distributed and consumed (Walter and Hoover, 1986).

A major problem in the manufacture of SP products is discoloration which masks the natural orange color and produces a gray or greenish-orange color (Hoover, 1963). Recently, there has been an increase in the consumption of French-fried white potatoes. In the last decade and in 1978 there was a consumption of 18.1 kg per person per year (USDA, 1980). The availability of a similar product prepared from SP may not offer significant competition. Several researchers have, however, prepared fried chips from SP (Hoover and Miller, 1973; Kelley et al., 1958; Olorunda and Kitson, 1977). The major problem encountered was discoloration thought to be due to enzymatic and non-enzymatic browning (Spark, 1969). High temperature of frying increased the browning reaction. Hoover and Miller

(1973) treated chips with sodium acid pyrophosphate to eliminate discoloration, whereas, Olorunda and Kitson (1977) eliminated discoloration in chips prepared from white fleshed cultivars of SP by use of a sodium sulfite ( $\text{SO}_2$ ) dip. These chemical treatments served to block enzyme-caused phenolic discoloration and to remove some of the reducing sugars.

Flavor and texture are other qualities affected by both post-harvest handling and pre-frying processing conditions. Generally, cured and stored SP, when baked, are more flavorful than freshly harvested roots (Hammett and Barrentine, 1961). The increase in desirable flavor is due to development of increased sugar content and unknown flavor components (Hamann et al., 1980).

A french-fried SP product prepared by Kelley et al. (1958) possessed excellent quality. The frozen, fried slices were oven cooked before being consumed. Desirable color, texture and flavor were reported for fries prepared from cured SP with 1 month storage. Inferior texture and taste were reported for the fries, when the SP were stored 6 months. Hoover and Miller (1973) reported on high quality chips with SP. The chips prior to frying were blanched in water, containing 0.25 - 1.0% sodium acid pyrophosphate for 2 min at 93.3°C.

Hoover et al. (1983) produced patties from cured and stored sweet potatoes. They reported that addition of 8-12%

unmodified cornstarch and 10-12% sucrose provided the most acceptable patties. Ingredients such as raisins, pineapples, diced ham, orange flavor, coconut, imitation butter have been added to form sweetpotato products to diversify its flavor (Collins et al., 1974). These researchers found no decline in quality after frozen samples stored at  $-25^{\circ}\text{C}$  for 45, 90 or 135 days were evaluated after warming to  $177^{\circ}\text{C}$ .

In many subtropical and tropical countries white fleshed SP flour or puree is substituted in recipes for 10 to 20% of the wheat flour which has limited availability and is expensive for bread making. At these SP flour levels, properties of the baked products are altered. SP flour at 30% may be used in cakes without affecting the volume of the cake. Incorporation of 21% SP flour or puree into yeast-raised doughnuts altered a number of the physical and chemical properties of the doughnuts (Collins and Abdul Aziz, 1982). However, overall acceptability was not reduced.

#### C. Chemical And Nutritional Attributes of Sweet Potatoes

Several researches (Cooley, 1948; Goodbody, 1984; Picha, 1985; Thompson, 1984) worked with different cultivars of SP. Picha (1985) found the mean crude protein content of 'Jaspar,' 'Travis,' 'Centennial' and 'Jewel' to be 1.38,

1.36, 2.13 and 1.44g/100g (wet weight basis), respectively. Differences among cultivars have been attributed to production practices and environmental conditions (Constantin et al. 1974). The recommended dietary allowance (RDA) of protein for the adult male and female are 56g and 44g, respectively, which make it difficult to consider SP a suitable source of protein. To meet the RDA, a tremendous quantity of SP must be consumed (Picha, 1985). Although the protein content of SP is low, Walter and Catignani (1981) reported that the protein efficiency ratio (PER) of isolates and concentrates is equal to that of casein. PER of 2.2 and 1.8 (relative to 2.5 for casein) were reported by Walter and Catignani (1983). Protein from some SP cultivars has been reported by several researchers as deficient in total sulfur and lysine (Purcell et al., 1972).

At harvest, 75% to 90% of raw SP dry matter is carbohydrate which contains about 46.2% starch, 22.4% sugars, 3.8% hemicellulose, 2.7% cellulose and 0.47% water insoluble pectin. In baked SP, these values are lower for each parameter given except for sugar which is increased (Picha, 1985). The starch component consists of 60 to 70% amylopectin with the remainder as amylose (Bertoniere et al., 1966). The most abundant sugar is sucrose (raw SP) with small quantities of glucose and fructose. The large part of the caloric value of SP (4.1 Kcal/g, dry weight) is composed of the carbohydrate. Picha (1985) reported the

total carbohydrate content (dry weight basis) of the SP root as 89.5%. The author found that storage of the roots at 32°C, 15.6°C or 7°C for extended periods of time decreased the starch content and increased the concentrations of sucrose, glucose and fructose. Chips prepared from such roots were darker than chips from prestored roots.

Dietary fiber (DF) refers to that group of components of food that is not digested in the digestive tract. DF includes hemicelluloses, pectic substances, gums, mucilages, legnins and celluloses. Recent studies indicated that increased consumption of dietary fiber may have reduced the incidence of diseases such as colonic cancer, diabetes, heart disease and certain digestive diseases (Kimura, 1977). Lund and Smoot (1982) reported the 'Jersey' SP to contain 3.76% cellulose, 0.46% hemicellulose and 0.44% lignin (dry matter), while Shen and Sterling (1981) found 3.26% cellulose, 4.95% hemicellulose and 0.5% insoluble pectin. A diet rich in DF promotes increased excretion of bile acids, sterols and fats, implying that DF "binds" bile acids and, thereby, prevents absorption of bile acid derived from the body's cholesterol (Stanley, 1970). Consequently, the body draws on its cholesterol stores to synthesize more bile acids and, presumably, results in a lowering of blood (serum) cholesterol level.

SP provides certain vitamins. Beta-carotene (pro-vitamin A) and ascorbic acid (vitamin C) are the most

abundant vitamins. SP provides about 880 retinol equivalents (RE)/100g of pro-vitamin A, an essential nutrient for epithelial tissue maintenance, reproduction, growth and normal vision (Mathia, 1975). The deep orange color of certain cultivars is due to high level of beta-carotene. Elkins (1979) reported 9,694 µg/100g beta-carotene in raw SP and 5,936 µg/100g in the canned counterpart. Ascorbic acid content in raw SP was 29.8mg/100g while canned SP contained 20mg/100g. The beta-carotene content remained at the same level when the SP roots were stored for 18 months, but the ascorbic acid content decreased by almost 50%. Beta-carotene content in the orange-fleshed cultivars preferred in the United States is sufficient to provide several days' supply of vitamin A per serving. White-fleshed or cream-colored SP flesh contain little or no beta-carotene.

Watt and Merrill (1963) reported 20 to 50 mg/100g (fresh weight basis) ascorbic acid in SP. These authors presented the thiamin, riboflavin and niacin contents in boiled SP as 0.07, 0.05 and 0.51 mg/100g, respectively. Mineral contents of SP are generally low when considered against the amount required for satisfactory human nutrition. Elkins (1979) reported mineral contents of the 'Centennial' as follows; calcium 32.7, phosphorus 48.9, magnesium 22.2, sodium 8.0, potassium 228.0, iron 0.85, copper 0.25, magnesium 0.59 and zinc 0.26 mg/100g. Sodium

content is low and beneficial to individuals on a restricted sodium intake diet. Mineral contents differ among cultivars. Picha (1985) reported 341 mg/100g potassium in 'Jasper' and 245 mg/100g in 'Travis.'

Hoover and Miller (1973) reported decreased fat content of the fried chips as percentage of moisture of the SP slices decreased. An initial moisture content of 79.4% prior to frying produced chips with 37.6% fat and 2.4% moisture. At 16.7% moisture prior to frying, chips contained 18.8% fat and chip moisture. The fat content for raw flesh of Puerto Rico-type cultivars has been reported at 0.2% and moisture at 70% (Crosby, 1963). SP is an excellent source of gross energy (114 Kcal/100g) (Mathia, 1975).

#### D. Deep Frying

Deep-fried foods are popular among North American consumers. In deep-frying, the food is submerged in hot oil until cooked (Stevenson et al., 1984). This method is more efficient than the dry heat of an oven and more rapid than boiling in water since the higher temperatures of frying result in more rapid penetration of heat into the product (Stevenson et al., 1984).

In deep-frying, numerous decomposition products are produced by a complex series of changes. As frying takes place functional, sensory and nutritional qualities of the

frying oil are altered and affect certain quality factor of food being cooked. During deep-frying, the moisture of the food is lost into the frying oil and oil is absorbed by the food. The presence of air and moisture contribute to thermal and oxidative deterioration of the oil which may produce volatile decomposition products (VDP) and nonvolatile decomposition products (NVDP). The formation rate of decomposition products is dependent upon type of frying oil, fryer design, nature of the operating conditions, oxygen uptake and level of moisture (Fritsch, 1981; Stevenson et al., 1984). VDP are removed during frying by the steam generated during cooking. However, an amount of VDP is retained in the food.

The NVDP formation is due mainly to polymerization of the unsaturated fatty acids present in the frying medium. The acids cause further deterioration in food during storage and are responsible for physical changes in the frying fat such as increased viscosity, color and foaming. Also, chemical changes take place such as increases in free fatty acids, carbonyl value, hydroxyl content and saponification value and increased formation of high molecular weight products (Perkins, 1967).

As the level of unsaturation increases, the rate of oxidation increases. This phenomenon may explain, in part, the reason why oils such as soybean and canol with high linolenic acid are not preferred over corn with low levels



of linolenic acid. Partial hydrogenation could be used, however, to reduce the linolenic acid content of soybean oil.

A lightly hydrogenated oil after use for frying for 100 hrs was reported to have a reduction of 50% in total linoleic and linolenic acids, thereby increasing the relative amount of total saturated fatty acids (Thompson and Aust, 1983). This finding was supported by findings of Miller and White (1988) who reported 7 to 11.5% decrease in linoleic acid and 27 to 46% decrease in linolenic acid. They found an increase of saturated acids in soybean oil heated at 180°C for 40 hr.

During frying, water moves by mass transfer from the central portion of the food product radially outward to the walls and edges to replace that lost by dehydration of the exterior surface (Blumenthal, 1991). This movement of water was described by Keller and Escher (1989) as "pumping" which can be observed in the laboratory by examining the cross-sections of food pieces as they fry over a period of time (Blumenthal, 1991).

Moisture in the food during frying causes hydrolysis and produces free fatty acids, mono-and di-glycerides and glycerine which aid in rapid deterioration of the oil. The formation of dimers and cyclic compounds from polymerization occur also due to the presence of heat used during frying. During deep-frying SP chips, color change of the oil occurs

due to leaching of the fat-soluble carotenes into the oil (Fritsch, 1981).

To extend shelf life of frying oil, capacity of the fryer should allow maximum production with the least possible amount of frying oil (Stevenson et al., 1984) and lowest temperature for optimum product quality. The fryer should be cleaned and all traces of detergents removed and the turn-over rate should be 15 to 25% of the fryer capacity.

For products that require extended shelf life, it is important to use hydrogenated or partially hydrogenated oils. However, in the snack industry the product is consumed cold and frying with a highly hydrogenated oil will produce a product with less desirable mouth feel due to the "greasy" nature of the product.

#### E. Peroxide Value

Mehlenbacher (1960) defined peroxide value (PV) of a fat as a measure of its reactive oxygen content expressed in terms of milliequivalents of oxygen per kilogram of fat or as millimoles of peroxide per kilogram of fat. After frying, potato chips and other fried products retain part of the oil of the fryer. During storage, the oil retained undergoes oxidative changes. In the presence of oxygen the absorbed oil will autoxidize, leading to deterioration in

flavor of the food product described as rancidity. Other factors affecting rate of oxidation are degree of unsaturation of the oil, presence of antioxidants, presence of prooxidants, especially copper, nature of packaging material, light exposure and temperature of storage (deMan, 1980).

The process for production of peroxide (autoxidation) may be divided into 3 steps: 1. the initial stage in which a free radical is produced by removal of hydrogen from an olefinic compound; 2. the propagation stage in which the free radical formed combines with oxygen to form a peroxy-free radical which can also abstract hydrogen from another unsaturated molecule to yield a peroxide and a new free radical; and 3. the termination stage which occurs when the free radicals react with other free radicals to yield non-active products. The peroxides formed are not important in flavor deterioration; however, they decompose into the secondary oxidation products such as carbonyls which are of concern.

Many researchers used several methods to track or monitor oxidative stability of fats or oil and fried food products (Min and Schweizer, 1983; Quast and Karel, 1972). Peroxide measurement is a commonly used method. deMan (1980) reported that PV is used to measure progress of oxidation because peroxides are easily determined in fats. He suggested that measurement of organoleptic changes that

relate closely to the secondary oxidation products could be achieved by using the benzidine value which is related to aldehyde decomposition products. However, Min and Schweizer (1983) indicated that this method alone was not a satisfactory indicator of flavor because the PV increased to a maximum and then decreased as storage increased. This method is useful in products as potato chips which are generally not stored for extended periods of time before consumption.

## CHAPTER III

### MATERIALS AND METHODS

#### A. Source and Preparation of Sweet Potatoes

Sweet potato (Ipomoea batatas, Lam) (SP) roots of orange flesh, red skin and a moist-type unknown cultivar were purchased at a local fresh market. The SP were grown in Alabama. The roots were washed, cut into 1.2 cm slices and immersed immediately into 0.25% citric acid solution to inhibit discoloration. The slices were heated in an atmospheric pressure blancher for 10 min, cooled with a spray of tap water and returned to a solution of 0.25% citric acid solution for holding. The peel (epidermis) was removed by hand with a knife as the slices were held in citric acid solution. The peeled slices and the separated skins (peel) were packaged separately in plastic bags of 2.4 kg capacity. The packages were frozen and held at 0°C for pureeing and drying. Flour was prepared from the dried SP.

#### B. Flour Production

Prior to pureeing, the SP flesh and skins were allowed to thaw in a refrigerator. The flesh and skins were pureed

separately in a kitchen model food processor (Osteriser, Oster Corporation, Milwaukee, WI.) for 2 min.

SP puree of flesh and skin were dried separately on a double drum-dryer (model 214-501, Stokes Processing Equipment Co., Philadelphia, PA) at the Food Science Department, University of Georgia, Athens, GA. The flakes were packaged under vacuum, placed in a cardboard box to exclude light and stored at 0°C.

Flakes were ground into flour as needed to preserve color, flavor and carotene content. Flour was produced from the flesh (FSPF) and skin (FSPS) by grinding the appropriate flakes in a micro-mill (Bel-Art Products, Pequannock, NJ). The flour was passed through U.S. No. 80 mesh sieve and stored in glass jars in the dark at 5°C. Flour was produced from commercially prepared white potato flakes which were purchased from a local grocery store. Flakes were ground in a micro-mill as needed and used for dough formulation.

### C. Dough Formulation and Preparation

Following a period of preliminary investigation, the formulations in Tables 1 and 2 were developed and considered appropriate for making fabricated SP chips.

For each type of flour (FSPF and FSPS), 4 formulations were prepared. Levels of flour at the rates of 25, 50, 75 and 100g were incorporated into 100g white potato flour.

Table 1 - Formulation for chips prepared with flour of sweet potato and white potato flesh

| Ingredients <sup>a</sup> | Levels of FSPF                                  |       |       |       |
|--------------------------|-------------------------------------------------|-------|-------|-------|
|                          | 25                                              | 50    | 75    | 100   |
|                          | - - - - - grams/100g WPF <sup>b</sup> - - - - - |       |       |       |
| FSPF                     | 12.08                                           | 20.58 | 27.41 | 33.35 |
| WPF                      | 48.30                                           | 41.15 | 36.55 | 33.35 |
| Salt                     | 0.97                                            | 1.23  | 1.28  | 1.33  |
| BHA                      | 0.02                                            | 0.02  | 0.02  | 0.03  |
| Water                    | 38.64                                           | 37.04 | 34.72 | 33.35 |

<sup>a</sup> FSPF = Flour of sweet potato flesh.

<sup>b</sup> WPF = White potato flour prepared from commercially prepared flakes.

BHA = Butylated hydroxyanisol as antioxidant.

Table 2 - Formulation for chips prepared with flour of sweet potato skin and white potato flour

| Ingredients <sup>a</sup> | Levels of FSPS                                  |       |       |       |
|--------------------------|-------------------------------------------------|-------|-------|-------|
|                          | 25                                              | 50    | 75    | 100   |
|                          | - - - - - grams/100g WPF <sup>b</sup> - - - - - |       |       |       |
| FSPS                     | 11.50                                           | 19.75 | 22.72 | 28.16 |
| WPF                      | 46.00                                           | 39.50 | 30.24 | 28.16 |
| Salt                     | 0.92                                            | 1.19  | 1.50  | 1.40  |
| BHA                      | 0.02                                            | 0.02  | 0.02  | 0.02  |
| Water                    | 41.40                                           | 39.50 | 45.45 | 42.25 |

<sup>a</sup> FSPS = Flour of sweet potato skin.

<sup>b</sup> WPF = White potato flour prepared from commercially prepared flakes.

BHA = Butylated hydroxyanisol as antioxidant.



Other ingredients of salt (in some formulations), butylated hydroxyanisol and water were included in the formulations. Dough was prepared from these ingredients.

After all the dry ingredients were thoroughly mixed, water was added to the dry ingredients and stirred to form dough.

Chips that contained salt had 1.5% of salt added as an ingredient.

Kneading for about 5 min produced a smooth dough which was flattened on a tray with a dough roller. The smooth, flattened dough was fed between the smooth rollers of a kitchen model pasta maker which produced a smooth sheath of dough with 0.1 mm in thickness. The dough was perforated by pricking with pins and cut with a biscuit cutter into circular pieces of 3.8 mm diameter.

#### D. Chip Production

Prior to frying, 14.5 kg of oil were placed in a Gold Medal Model FW-12 shallow Fryer (Gold Medal Products Co., Cincinnati, OH), heated to 177°C and held for 2 hr. Each batch was fried for 14 seconds. During each fry time, 12 pieces of the cut dough were placed in a single layer between 2 frying racks and the racks were immersed completely in the hot oil. Fry times and temperatures were determined during preliminary studies. Temperature of the

oil dropped to about 168°C upon immersion of the racks and dough pieces into the oil. After frying, the chips were removed, drained of excess oil and placed on a tray to cool for 5 min. Chips for use in the storage study were placed immediately in 325 mL glass jars. A portion of the jars were flushed with nitrogen gas and stored in the dark case at ambient room temperature. Another portion of the jars were not flushed, thus the atmosphere surrounding the chips consisted of air. Chips were held for 0, 3, 6 and 9 weeks and analyzed for texture, color, beta-carotene and peroxide value (PV).

Salted and unsalted chips prepared for sensory evaluation were held in glass jars under nitrogen gas or air and stored for 9 weeks in the dark case at ambient room temperature.

#### E. Physical Tests

##### Color Analysis:

Color of SP chips was measured with the Hunter Color Difference Meter (Model D25D2M). The meter was standardized with the white tile (No. C2-21125) with the following values: L = 91.03, 'a' = -1.3 and 'b' = 1.6.

Three chips were placed carefully in a cuvette to completely cover the optical glass bottom. The Hunter values L, 'a' and 'b' were recorded.

### Firmness Analysis:

Force needed to break the chips was measured with the Instron Universal Testing Machine (Model 1132). A load cell of 5 kg capacity was used with the crosshead and chart speeds set at 10 and 25 cm per min.

A 2.5 cm long blade of 3.2 mm thick was attached to the load cell and allowed to come in contact with a chip positioned carefully on a support made with 2 bars adjusted 6.4 mm apart. Five chips were evaluated individually for each treatment and 3 out of the 5 readings with similar values were used for further calculations. Values were reported in grams force to break the chips.

## F. Chemical Tests

### Proximate Analysis:

#### Moisture:

The AOAC (1980) vacuum oven method 22.018 was used to determine the moisture of the chips at 100°C at 584 mm Hg for 6 hr. The chips were ground and 2g of the powder were used.

#### Fat:

The total lipid content of the ground chips was determined according to the standard AOAC (1980) method.

Two grams of moisture-free material were extracted with 50 mL anhydrous ethyl ether for 6 hr.

Ash:

The AOAC (1980) dry ashing method 32.012 was used. Two g of the material were ashed in a muffle furnace at 580°C for 6 hr.

Dietary Fiber:

The method described by Prosky et al. (1985) was used to determine the dietary fiber content of the chip material. Four, 1-g defatted samples were analyzed.

Protein:

The Kjeldahl method was used to determine the crude protein content of the samples. Two-g samples were analyzed, using the Kjeltec 1015 Digester and Kjeltec 1026 Distilling unit (Perstorp Analytical, Silver Springs, MD.). The sample, 2 keltabs ( $\text{CuSO}_4$ ) and 15 ml of sulfuric acid were mixed in a 250 mL digestion tube and digested 45 min. The digested samples were distilled with the 1026 Distilling Unit. Protein was determined by the factor  $N \times 6.25$ .

### Carbohydrate:

Percentage of carbohydrate was calculated by subtracting the percentages of fat, ash, dietary fiber and crude protein from 100%.

### Beta Carotene:

Beta carotene of 2-g samples of the SP material was extracted 4 hr with anhydrous petroleum ether, using the soxhlet apparatus and analyzed according to method described by Holden (1985). Ether was evaporated after extraction and the extract was dissolved in 25 mL HPLC-grade hexane. A 0.45 micron filter was used to filter the solution and 20 mL were injected into a Waters HPLC instrument (Water Assoc., Milford, MA, Model 6000A solvent delivery system with a U6K injector) for analysis. A Waters Micro Beondapak C-18 column was used to separate the compounds. A 15:85 (V/V) acetone and hexane mixture was used as the carrier liquid (liquid phase). The spectrophotometer absorbance detector was set at 452 nm and the flow rate of the liquid phase was 2 mL per min. HPLC-grade hexane was used to prepare a standard solution containing 0.002 mg/mL beta carotene (Sigma Chemical Co., St. Louis, MO). One, 5, 10, 15 and 20 mL of the standard solution were injected into the HPLC and the results were used to obtain a standard curve. The beta carotene content was reported as retinol equivalents (RE).

### Gross Energy:

Gross energy was determined by the procedure of Parr Instrument Company (1981). Approximately 0.8g of sample was placed in the combustion capsule for measurement with the Parr Adiabatic Oxygen Bomb Calorimeter (model 124). The values obtained were reported in Kilojoules (Kj) per g.

### Minerals:

Iron, calcium, magnesium, potassium, sodium, and phosphorus were determined on the chip samples. One g sample was weighed into a 250 mL beaker, 60 mL of concentrated nitric acid were added and the mixture was boiled to near dryness, allowed to cool and covered with 7 mL reagent-grade perchloric acid. The beaker with the digested material was covered with a watchglass until the reaction terminated, then the cover was removed and the solution was evaporated until approximately 1 mL solution remained. The solution was then diluted with 25 mL distilled water. An atomic absorption spectrophotometer, (model 551, Intrumentation Laboratory, Inc., Wilmington, Ma.) was used to determine the mineral contents.

### Peroxide Value:

PV of the SP materials were determined, according to procedures of Mehlenbacher (1960). Fifteen g SP chips were blended 30 seconds in a Waring Blender with 175 mL

chloroform, free of peroxides. The mixture was filtered immediately through No. 1 Whatman filter paper on a Buchner funnel under vacuum.

A 25 mL aliquot of the filtrate was placed in a 150 mL beaker and 25 mL aliquot was placed in another 125 mL Erlenmeyer flask. The chloroform in the 150 mL beaker was evaporated on a water bath under a stream of nitrogen and dried (for 5 min) to constant weight in a vacuum oven at 95°C. The weight of lipid from this beaker was used as the sample weight for the calculation of PV. The material in the 125 mL Erlenmeyer flask was covered with 18.5 mL glacial acetic acid and 1 mL saturated potassium iodide solution. The mixture was allowed to stand for 1 min with occasional shaking, then 15 mL distilled water were added. The mixture was titrated with 0.01N sodium thiosulfate with 0.5 mL starch solution as indicator.

$$\text{PV (meq/kg fat)} = \frac{\text{mL} \times \text{N} \times 1000}{\text{Wt. of sample}}$$

Wt. of sample

mL = volume of sodium thiosulfate used for titration

N = normality of sodium thiosulfate

#### G. Sensory Evaluation

A panel of 25 untrained people provided descriptive analysis of the chips for color, texture and overall acceptability with an 8-point hedonic scale (ranging from

dislike extremely to like extremely). Sensory evaluation was conducted on chips stored for 9 weeks. The chips were coded with 3 digit random numbers and presented to the 25 recruited panelists in random order. An initial screening sensory was conducted to determine reactions of the panelists to chips which were (1) fried in oil, (2) passed through a hot air conveyor oven, (3) prepared with sweet potato puree and (4) prepared with SP skins. Analysis of the data indicated that some of the samples of chips did not merit further study. Thus, a decision was made to pursue evaluation of chips prepared with SP flesh and skin flours and finished in hot oil. Four levels of chips were prepared as described in the "chip preparation" section.

Each of the 25 panelists was presented with 4 chips one at a time (4 different treatments) each day in an individual booth under a white light (IFT, 1971). Panelists were asked to evaluate the chips for color, texture and overall acceptability. Eight days of sensory evaluation were conducted, the first 4 days were used to analyze chips prepared with flour of SP flesh and the remaining 4 days were used to analyze chips prepared with flour of the SP skin. The same panelists were used to evaluate all the samples of a particular type of flour.



#### H. Experimental Design and Statistical Analyses

The data were subjected to analysis of variance as factorials of a completely randomized block (Little and Hills, 1978). The factorial for proximate analysis, gross energy and mineral contents was  $4 \times 3$  (levels of SPF  $\times$  replication) and the factorial for sodium content for salted chips was  $4 \times 2$  (levels of SPF  $\times$  replication). For color, PV, texture and beta-carotene, a factorial of  $4 \times 4 \times 2 \times 2$  (SP level  $\times$  storage period  $\times$  gaseous atmospheres  $\times$  levels of salt) factorial was used. Three replications were prepared. For sensory evaluation, a factorial of  $25 \times 4 \times 2 \times 2$  (panelists  $\times$  levels of SPF  $\times$  gaseous atmospheres  $\times$  levels of salt) was used.

The General Linear Model procedure (GLM) was used to analyze all the data except the sensory data which was analyzed by the General Linear Mixed Models (GLMM) procedure. Significant differences among means from the GLM procedure was determined with the Student Newman-Keul (SNK) technique at  $P < 0.05$ . GLMM was used to obtain standard errors against which least squares means were compared. The statistical analysis was performed using the Statistical Analysis System (SAS, 1985) programs.

## CHAPTER IV

### RESULTS AND DISCUSSIONS

#### A. Chemical Tests

##### Proximate Analysis:

Sums of squares from the analysis of variance for proximate composition of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato are presented in Table 3. Levels of FSPF affected moisture and ash at  $P < 0.01$  and crude protein, crude fat and dietary fiber at  $P < 0.05$ . Levels of FSPS affected moisture, crude fat, ash and dietary fiber at  $P < 0.01$  and crude protein and carbohydrate at  $P < 0.05$ .

Proximate composition of chips with FSPF or FSPS and white potato is presented in Table 4. Moisture of chips decreased as levels of FSPF increased from 25 to 50%. No further change occurred as levels increased to 100%. The decrease in moisture content may be attributed to slight variations in initial moisture of dough prior to frying, oil temperature and fry-time. Levels of FSPS had similar effects on moisture, except that 100% FSPS produced greater moisture than 50 and 70% FSPS.

Moisture content of these chips can be controlled because it is added to flours during dough formulation.

Table 3 - Sums of squares from the analysis of variance for proximate composition of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato

| Source        | df | Crude              |                    |                    | Dietary            |    |                                       |
|---------------|----|--------------------|--------------------|--------------------|--------------------|----|---------------------------------------|
|               |    | Moisture           | Protein            | Fat                | Ash                | df | Fiber Carbohydrate                    |
| FSPF          |    |                    |                    |                    |                    |    |                                       |
| Level of FSPF | 3  | 0.07**             | 0.68*              | 11.85*             | 0.38**             | 3  | 1.09* 8.56 <sup>ns</sup>              |
| Replication   | 2  | 0.01 <sup>ns</sup> | 0.13 <sup>ns</sup> | 2.08 <sup>ns</sup> | 0.01 <sup>ns</sup> | 1  | 0.01 <sup>ns</sup> 2.75 <sup>ns</sup> |
| Error         | 6  | 0.01               | 0.14               | 2.45               | 0.02               | 3  | 0.07 1.95                             |
| FSPS          |    |                    |                    |                    |                    |    |                                       |
| Level of FSPS | 3  | 0.41**             | 0.88*              | 50.49**            | 3.81**             | 3  | 0.42** 25.83*                         |
| Replication   | 2  | 0.01 <sup>ns</sup> | 0.01 <sup>ns</sup> | 2.27 <sup>ns</sup> | 0.03 <sup>ns</sup> | 1  | 0.07** 1.36 <sup>ns</sup>             |
| Error         | 6  | 0.02               | 0.24               | 1.82               | 0.34               | 3  | 0.00 1.56                             |

\* Significant at  $P < 0.05$ .  
 \*\* Significant at  $P < 0.01$ .  
 ns Not significant at  $P < 0.05$ .

Table 4 - Proximate composition of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato

| Levels of<br>SPF, % <sup>a</sup>            | Moisture          | Crude<br>Protein  | Crude<br>Fat       | Ash               | Dietary<br>Fiber   | Carbo-<br>hydrate  |
|---------------------------------------------|-------------------|-------------------|--------------------|-------------------|--------------------|--------------------|
| - - - - - g/100g DWB <sup>b</sup> - - - - - |                   |                   |                    |                   |                    |                    |
| FSPF                                        |                   |                   |                    |                   |                    |                    |
| 25                                          | 3.59 <sup>c</sup> | 5.03 <sup>c</sup> | 16.76 <sup>c</sup> | 2.54 <sup>d</sup> | 4.34 <sup>d</sup>  | 71.33 <sup>c</sup> |
| 50                                          | 3.40 <sup>d</sup> | 4.61 <sup>d</sup> | 14.54 <sup>d</sup> | 2.51 <sup>d</sup> | 4.54 <sup>d</sup>  | 73.80 <sup>c</sup> |
| 75                                          | 3.36 <sup>d</sup> | 5.25 <sup>c</sup> | 14.23 <sup>d</sup> | 2.88 <sup>c</sup> | 4.84 <sup>cd</sup> | 72.80 <sup>c</sup> |
| 100                                         | 3.36 <sup>d</sup> | 5.11 <sup>c</sup> | 14.76 <sup>d</sup> | 2.88 <sup>c</sup> | 5.32 <sup>c</sup>  | 71.93 <sup>c</sup> |
| FSPS                                        |                   |                   |                    |                   |                    |                    |
| 25                                          | 3.71 <sup>c</sup> | 1.35 <sup>d</sup> | 17.20 <sup>d</sup> | 2.18 <sup>d</sup> | 4.74 <sup>e</sup>  | 74.53 <sup>c</sup> |
| 50                                          | 3.29 <sup>e</sup> | 1.28 <sup>d</sup> | 18.21 <sup>d</sup> | 3.57 <sup>c</sup> | 4.57 <sup>f</sup>  | 72.37 <sup>c</sup> |
| 75                                          | 3.26 <sup>e</sup> | 1.53 <sup>d</sup> | 21.19 <sup>c</sup> | 2.66 <sup>d</sup> | 5.01 <sup>d</sup>  | 69.61 <sup>d</sup> |
| 100                                         | 3.53 <sup>d</sup> | 1.98 <sup>c</sup> | 15.55 <sup>e</sup> | 3.41 <sup>c</sup> | 5.16 <sup>c</sup>  | 73.90 <sup>c</sup> |

N = 3.

<sup>a</sup> Percent sweet potato flour based on amount of white potato flour; SPF = sweet potato flour.

<sup>b</sup> g/100g DWB indicates grams per 100g of chips calculated on dry weight basis.

<sup>c-f</sup> Means in a column for each SPF followed by different superscripts are different at P<0.05.

Crude protein content of chips with the 2 types of sweet potato flour (SPF) were essentially similar at the different levels of SPF. Crude protein of chips with FSPF was 3.3 times greater than chips with FSPS, reflecting the greater amount of protein in FSPF.

Crude fat content of chips decreased as level of FSPF increased from 25 to 50% with no change as FSPF increased to 100%. Crude fat of chips with FSPS was greatest at 100% FSPS and lowest at 25 to 75%. Fat content in this study was lower than the mean 52.3% reported by Bozorgmehr (1987) for chips prepared from slices of SP. The present lower fat levels of chips with SPF, most likely, was caused by a greater solids content and, conversely, lower moisture and the particular thickness of chips, temperature of fat during frying and time of heating used.

Ash tended to decrease in chips with increased SPF, reflecting a greater level of ash in SPF than in white potato flour (USDA, 1984). Ash was similar in the 2 groups of chips; ash of chips with FSPS was only a mean 1.07% greater than that of chips with FSPF.

Dietary fiber tended to increase in chips as SPF increased. Such SP chips with the mean 4.8% dietary fiber would offer an important dietary contribution.

Levels of FSPF had no effect on carbohydrate content while FSPF had a slight effect. That effect provided no

trend in the change of carbohydrate level and probably was unimportant.

Chips produced in these research have advantage over those cut from roots because their shapes, sizes and solid contents can be controlled.

### Retinol Equivalents

Sums of squares from the analysis of variance for retinol equivalent (RE) of chips with FSPF or FSPS and white potato are presented in Table 5. RE of chips with FSPF was affected ( $P<0.01$ ) by all the main factors and their interactions while RE of chips with FSPS was affected ( $P<0.01$ ) by all of the main factors, except gaseous atmosphere, and some of the interactions.

Table 6 presents mean amounts of RE of chips with SPF as affected by the primary factors. RE was used as an indirect means of presenting beta-carotene and represents the vitamin A potential. As levels of both SPF increased, RE increased. Chips with FSPF contained a 3.9-fold greater amount RE. Flushing the container of chips that contained FSPF with nitrogen gas reduced loss of RE as compared to loss caused by air. Chips held under nitrogen had 5% more RE. The gaseous atmospheres had no effect on RE in chips with FSPS. Salt as an ingredient of chips contributed to a small but significant loss of RE in both types of chips. Percentage loss of RE was similar between the 2 types of

Table 5 - Sums of squares from the analysis of variance for retinol equivalent content of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato

| Source                | df  | FSPF                  | FSPS                 |
|-----------------------|-----|-----------------------|----------------------|
| Level of SPF (L)      | 3   | 8053482.60**          | 214298.27**          |
| Gas (G)               | 1   | 39546.40**            | 0.26 <sup>ns</sup>   |
| Salt (S)              | 1   | 2465.40**             | 314.52**             |
| Weeks of Storage (WS) | 3   | 447734.80**           | 7056.52**            |
| L x G                 | 3   | 41760.10**            | 1475.22**            |
| L x S                 | 3   | 18774.20**            | 1430.22**            |
| L x WS                | 9   | 43620.10**            | 105.67 <sup>ns</sup> |
| G x S                 | 1   | 56245.90**            | 1716.91**            |
| G x WS                | 3   | 9900.90**             | 624.50**             |
| S x WS                | 3   | 3748.50**             | 126.43 <sup>ns</sup> |
| L x G x S             | 3   | 112893.10**           | 753.37**             |
| L x G x WS            | 9   | 22386.00**            | 124.06 <sup>ns</sup> |
| L x S x WS            | 9   | 11499.80**            | 203.98 <sup>ns</sup> |
| G x S x WS            | 3   | 27364.40**            | 24.27 <sup>ns</sup>  |
| L x G x S x WS        | 9   | 4741.50 <sup>ns</sup> | 203.61 <sup>ns</sup> |
| Error                 | 128 | 45373.90              | 5286.74              |

\* Significant at  $P < 0.05$ .

\*\* Significant at  $P < 0.01$ .

<sup>ns</sup> Not significant at  $P < 0.05$ .

Table 6 - Retinol equivalent (RE) of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of sweet potato, gaseous atmospheres, levels of salt and storage periods

| Sweet                 | Gaseous          |                  |                             | Salt             |                  | Storage,                    |                             |
|-----------------------|------------------|------------------|-----------------------------|------------------|------------------|-----------------------------|-----------------------------|
| Potato                | Atmospheres      |                  |                             | Levels           | FSPF FSPS        | weeks                       | FSPF FSPS                   |
| Flour, % <sup>a</sup> | FSPF             | FSPS             | RE/100g<br>DWB <sup>b</sup> | FSPF             | FSPS             | RE/100g<br>DWB <sup>b</sup> | RE/100g<br>DWB <sup>b</sup> |
| 25                    | 293 <sup>f</sup> | 102 <sup>f</sup> | Nitrogen<br>gas             | 543 <sup>f</sup> | 135 <sup>c</sup> | 525 <sup>d</sup>            | 134 <sup>d</sup>            |
| 50                    | 392 <sup>e</sup> | 112 <sup>e</sup> | Air                         | 514 <sup>d</sup> | 135 <sup>c</sup> | 532 <sup>c</sup>            | 136 <sup>c</sup>            |
| 75                    | 603 <sup>d</sup> | 140 <sup>d</sup> |                             |                  |                  |                             |                             |
| 100                   | 825 <sup>c</sup> | 188 <sup>c</sup> |                             |                  |                  |                             |                             |

N = 48 for levels of SPF; 96, gaseous atmospheres and levels of salt; 48, storage periods.

<sup>a</sup> Percentage sweet potato flour based on white potato flour.

<sup>b</sup> RE/100g DWB indicates retinol equivalent per 100 g calculated on dry weight basis.

<sup>c-f</sup> Means within a column followed by a different superscripts are significantly different at P<0.05.



chips. RE of chips with FSPF decreased with each period of storage while those of FSPS decreased after 3 weeks. After 9 weeks storage, chips with FSPF lost 21% RE while chips with FSPS lost 11% RE. The most desirable chips, in terms of RE contain 100% SPF, and are held for 0 weeks.

Sums of squares from the analysis of variance for RE of chips prepared with FSPF or FSPS and white potato as affected by levels of sweet potato flour (SPF) within each gaseous atmosphere are presented in Table 7. Similar information is presented in Table 8 for gaseous atmospheres within each level of SPF. Levels of SPF within nitrogen gas or air atmospheres affected ( $P<0.01$ ) RE of chips prepared with FSPF or FSPS (Table 7). Gaseous atmospheres within 100% FSPF affected ( $P<0.01$ ) RE. For chips with FSPS, gaseous atmospheres within 50 and 100% levels of SPF affected RE ( $P<0.01$ ) (Table 8).

RE are presented in Table 9 for chips prepared with FSPF or FSPS and white potato as affected by levels of SPF and 2 gaseous atmospheres. RE increased with each increase in level of both SPF and was applicable to chips held under both atmospheres. Three pairs of means as affected by gaseous atmospheres are indicated. Chips prepared with 100% FSPF and 50% FSPS had greater RE when held under nitrogen. The remaining treatment with 100% FSPS had higher RE when held under air. There was no trend as to effect of gaseous

Table 7 - Sums of squares from the analysis of variance for retinol equivalents of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of sweet potato within each gaseous atmosphere

| Source                                 | df | FSPF                     | FSPS                    |
|----------------------------------------|----|--------------------------|-------------------------|
|                                        |    | Sums of squares          |                         |
| Levels of SP flour within nitrogen gas | 3  | 4552141.10 <sup>**</sup> | 92821.51 <sup>**</sup>  |
| Error                                  | 88 | 166924.60                | 3462.61                 |
| Levels of SP flour within air          | 3  | 3543101.70 <sup>**</sup> | 122951.98 <sup>**</sup> |
| Error                                  | 88 | 123476.90                | 4795.75                 |

<sup>\*\*</sup> Significant at  $P < 0.01$ .

Table 8 - Sums of squares from the analysis of variance for retinol equivalents of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by two gaseous atmospheres within each level of sweet potato

| Source                                  | df | FSPF                   | FSPS                 |
|-----------------------------------------|----|------------------------|----------------------|
|                                         |    | Sums of squares        |                      |
| Gaseous atmospheres within 25% SP flour | 1  | 775.22 <sup>ns</sup>   | 18.88 <sup>ns</sup>  |
| Error                                   | 42 | 28620.86               | 669.24               |
| Gaseous atmospheres within 50% SP flour | 1  | 2051.08 <sup>ns</sup>  | 764.18 <sup>**</sup> |
| Error                                   | 42 | 55136.33               | 2236.02              |
| Gaseous atmosphere within 75% SP flour  | 1  | 2373.61 <sup>ns</sup>  | 26.74 <sup>ns</sup>  |
| Error                                   | 42 | 70256.54               | 2398.14              |
| Gaseous atmosphere within 100% SP flour | 1  | 76106.54 <sup>**</sup> | 665.68 <sup>**</sup> |
| Error                                   | 42 | 140140.20              | 3760.49              |

<sup>\*\*</sup> Significant at  $P < 0.01$ .

<sup>ns</sup> Not significant at  $P < 0.05$ .

Table 9 - Retinol equivalent of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of sweet potato flour and two gaseous atmospheres

| Atmosphere                                   | Levels of sweet potato flour, % <sup>a</sup> |                   |                   |                   |
|----------------------------------------------|----------------------------------------------|-------------------|-------------------|-------------------|
|                                              | 25                                           | 50                | 75                | 100               |
| - - - - - RE/100g DWB <sup>b</sup> - - - - - |                                              |                   |                   |                   |
| FSPF                                         |                                              |                   |                   |                   |
| Nitrogen gas                                 | g <sup>297f</sup>                            | g <sup>399e</sup> | g <sup>610d</sup> | g <sup>865c</sup> |
| Air                                          | g <sup>288f</sup>                            | g <sup>386e</sup> | g <sup>596d</sup> | h <sup>786c</sup> |
| FSPS                                         |                                              |                   |                   |                   |
| Nitrogen gas                                 | g <sup>102f</sup>                            | g <sup>116e</sup> | g <sup>139d</sup> | h <sup>187c</sup> |
| Air                                          | g <sup>101f</sup>                            | h <sup>107e</sup> | g <sup>140d</sup> | g <sup>191c</sup> |

N = 24.

a Percentage sweet potato flour based on amount of white potato flour.

b RE/100g DWB indicates grams per 100g calculated on dry weight basis.

c-f Means within a row followed by a different superscript are significantly different at P<0.05.

g-h Means in a column for each SPF preceded by a different subscript are significantly different at P<0.05.

atmosphere, and the treatments with significantly different means should be considered with reservations.

Sums of squares from the analysis of variance of retinol equivalents of chips prepared with FSPF or FSPS and white potato as affected by levels of SPF within each storage period are presented in Table 10. Similar information is presented in Table 11 for storage periods within each level of SPF. Levels of SPF within the 4 storage periods affected RE of chips with FSPF or FSPS ( $P < 0.01$ ) (Table 10). Storage within all levels of either SPF, except 25% FSPF ( $P < 0.05$ , affected ( $P < 0.01$ ) RE of chips (Table 11).

RE of chips prepared with both SPF and white potato are presented in Table 12. RE increased with each increase in level of both SPF, storage periods 0 to 9 inclusive. RE of chips with both SPF decreased as period of storage was extended. The percentage loss of RE during storage was greater for chips with FSPF, ranging from 15.0 to 25.7%, depending upon level of FSPF. Likewise, loss of RE in chips with FSPS ranged from 9.2 to 12.7, depending upon level of FSPS.

Sums of squares from the analysis of variance are presented for RE of chips prepared with FSPF or FSPS and white potato as affected by levels of SPF within each level of salt (Table 13). Similar information is presented in Table 14 for levels of salt within each level of SPF. RE of

Table 10 - Sums of squares from the analysis of variance for retinol equivalents of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of sweet potato within each storage period

| Source                               | df | FSPF            | FSPS       |
|--------------------------------------|----|-----------------|------------|
|                                      |    | Sums of squares |            |
| Levels of SP flour within<br>0 week  | 3  | 2309417.80**    | 55927.73** |
| Error                                | 42 | 59834.80        | 2446.67    |
| Levels of SP flour within<br>3 weeks | 3  | 2041130.20**    | 54760.38** |
| Error                                | 42 | 69922.00        | 2872.07    |
| Levels of SP flour within<br>6 weeks | 3  | 1936876.70**    | 52910.63** |
| Error                                | 42 | 90760.30        | 2315.59    |
| Levels of SP flour within<br>9 weeks | 3  | 1809678.00**    | 50805.21** |
| Error                                | 42 | 120521.70       | 3584.07    |

\*\* Significant at  $P < 0.01$ .

Table 11 - Sums of squares from the analysis of variance for retinol equivalents of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by storage periods within levels of sweet potato

| Source                       | df | FSPF            | FSPS      |
|------------------------------|----|-----------------|-----------|
|                              |    | Sums of squares |           |
| Storage within 25% SP flour  | 3  | 36503.47*       | 1383.87** |
| Error                        | 42 | 28620.86        | 669.23    |
| Storage within 50% SP flour  | 3  | 105202.98**     | 1647.74** |
| Error                        | 42 | 55136.33        | 2236.02   |
| Storage within 75% SP flour  | 3  | 225965.79**     | 1759.06** |
| Error                        | 42 | 70256.54        | 2398.14   |
| Storage within 100% SP flour | 3  | 123682.61**     | 2371.54** |
| Error                        | 42 | 140140.20       | 3760.49   |

\* Significant at  $P < 0.05$ .

\*\* Significant at  $P < 0.01$ .

Table 12 - Retinol equivalent of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) as affected by levels of flour and storage periods

| Storage, weeks                               | Levels of sweet potato flour, % <sup>a</sup> |                     |                     |                     |
|----------------------------------------------|----------------------------------------------|---------------------|---------------------|---------------------|
|                                              | 25                                           | 50                  | 75                  | 100                 |
| - - - - - RE/100g DWB <sup>b</sup> - - - - - |                                              |                     |                     |                     |
| FSPF                                         |                                              |                     |                     |                     |
| 0                                            | g <sup>334</sup> f                           | g <sup>459</sup> e  | g <sup>709</sup> d  | g <sup>900</sup> c  |
| 3                                            | h <sup>298</sup> f                           | h <sup>413</sup> e  | g <sup>709</sup> d  | h <sup>840</sup> c  |
| 6                                            | hi <sup>279</sup> f                          | i <sup>356</sup> e  | h <sup>562</sup> d  | hi <sup>797</sup> c |
| 9                                            | i <sup>260</sup> f                           | i <sup>341</sup> e  | i <sup>527</sup> d  | i <sup>765</sup> c  |
| FSPS                                         |                                              |                     |                     |                     |
| 0                                            | g <sup>106</sup> f                           | g <sup>118</sup> e  | g <sup>146</sup> d  | g <sup>195</sup> c  |
| 3                                            | g <sup>106</sup> f                           | gh <sup>115</sup> e | gh <sup>144</sup> d | gh <sup>193</sup> c |
| 6                                            | h <sup>100</sup> f                           | h <sup>110</sup> e  | h <sup>138</sup> d  | h <sup>186</sup> c  |
| 9                                            | i <sup>93</sup> f                            | i <sup>103</sup> e  | i <sup>130</sup> d  | i <sup>177</sup> c  |

N = 12.

a Percentage sweet potato flour based on amount of white potato flour.

b RE/100g DWB indicates grams per 100g calculated on dry weight basis.

c-f Means within a row followed by a different superscript are significantly different at P<0.05.

g-i Means in a column for each SPF preceded by a different subscript are significantly different at P<0.05.



Table 13 - Sums of squares from the analysis of variance for retinol equivalents of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of sweet potato within each level of salt

| Source                             | df | FSPF            | FSPS        |
|------------------------------------|----|-----------------|-------------|
|                                    |    | Sums of squares |             |
| Levels of SP flour within salted   | 3  | 3914322.70**    | 4310.57**   |
| Error                              | 88 | 236185.50       | 3827.23     |
| Levels of SP flour within unsalted | 3  | 4157934.20**    | 114920.11** |
| Error                              | 88 | 83354.20        | 4974.21     |

\*\* Significant at  $P < 0.01$ .

Table 14 - Sums of squares from the analysis of variance for retinol equivalents of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected levels of salt within each level of sweet potato

| Source                                 | df | FSPF                   | FSPS                  |
|----------------------------------------|----|------------------------|-----------------------|
|                                        |    | Sums of squares        |                       |
| Levels of salt within<br>25% SP flour  | 1  | 5409.52 <sup>**</sup>  | 363.17 <sup>**</sup>  |
| Error                                  | 42 | 28620.86               | 669.24                |
| Levels of salt within<br>50% SP flour  | 1  | 13119.25 <sup>**</sup> | 0.09 <sup>ns</sup>    |
| Error                                  | 42 | 55136.33               | 2236.02               |
| Levels of salt within<br>75% SP flour  | 1  | 44.63 <sup>ns</sup>    | 287.63 <sup>*</sup>   |
| Error                                  | 42 | 70256.54               | 2398.14               |
| Levels of salt within<br>100% SP flour | 1  | 2666.27 <sup>ns</sup>  | 1093.86 <sup>**</sup> |
| Error                                  | 42 | 140140.20              | 3760.49               |

\* Significant at  $P < 0.05$ .  
 \*\* Significant at  $P < 0.01$ .  
 ns Not significant at  $P < 0.05$ .

chips was affected ( $P < 0.01$ ) by levels of SPF in salted and unsalted chips with both SPF (Table 13). Levels of salt in chips with 25 and 50% FSPF and with 25% and 100% FSPS affected ( $P < 0.01$ ) RE (Table 14). Level of salt in chips with 75% FSPS affected ( $P < 0.05$ ) RE.

RE are presented in Table 15 for chips prepared with FSPF or FSPS and white potato as affected by levels of SPF and salt. RE of salted and unsalted chips with FSPF or FSPS increased as level of SPF increased above 50% SPF. In 2 cases (FSPF at 25% and FSPS at 75%) chips with salt had higher RE content while in 3 cases (FSPF at 50% and FSPS at 25 and 100%) unsalted chips had higher RE content. For 3 sets of data there was no difference.

Presented in Table 16 are sums of squares from the analysis of variance for RE of chips prepared with FSPF or FSPS and white potato as affected by gaseous atmospheres within each level of salt. Similar information is presented in Table 17 for levels of salt within each gaseous atmosphere. RE of all chips was affected by the gaseous atmospheres within each level of salt ( $P < 0.01$ ), except for unsalted chips with FSPS (Table 16). Levels of salt affected at  $P < 0.01$  RE of chips held under air (FSPF) and under nitrogen gas (FSPS). Levels of salt affected at  $P < 0.05$  RE of chips with FSPF when held in nitrogen gas and with FSPS when held in air.

Table 15 - Retinol equivalent of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) as affected by levels of sweet potato flour and levels of salt

| Salt                                         | Levels of sweet potato flour, % <sup>a</sup> |                    |                    |                    |
|----------------------------------------------|----------------------------------------------|--------------------|--------------------|--------------------|
|                                              | 25                                           | 50                 | 75                 | 100                |
| - - - - - RE/100g DWB <sup>b</sup> - - - - - |                                              |                    |                    |                    |
| FSPF                                         |                                              |                    |                    |                    |
| Salted                                       | f <sup>303</sup> e                           | g <sup>376</sup> e | f <sup>602</sup> d | f <sup>818</sup> c |
| Unsalted                                     | g <sup>282</sup> e                           | f <sup>409</sup> e | f <sup>604</sup> d | f <sup>833</sup> c |
| FSPS                                         |                                              |                    |                    |                    |
| Salted                                       | g <sup>99</sup> e                            | f <sup>112</sup> e | f <sup>142</sup> d | g <sup>183</sup> c |
| Unsalted                                     | f <sup>104</sup> e                           | f <sup>112</sup> e | g <sup>137</sup> d | f <sup>193</sup> c |

N = 24.

a Percentage sweet potato flour based on amount of white potato flour.

b RE/100g DWB indicates grams per 100g calculated on dry weight basis.

c-f Means within a row followed by a different superscript are significantly different at P<0.05.

g-h Means in a column for each SPF preceded by a different subscript are significantly different at P<0.05.

Table 16 - Sums of squares from the analysis of variance for retinol equivalents of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by two gaseous atmospheres within each level of salt

| Source                              | df | FSPF                 | FSPS     |
|-------------------------------------|----|----------------------|----------|
|                                     |    | Sums of squares      |          |
| Gaseous atmospheres within salted   | 1  | 95058.90**           | 837.50** |
| Error                               | 88 | 236185.50            | 3827.23  |
| Gaseous atmospheres within unsalted | 1  | 733.40 <sup>ns</sup> | 879.67** |
| Error                               | 88 | 83354.20             | 4974.21  |

\*\* Significant at  $P < 0.01$ .

<sup>ns</sup> Not significant at  $P < 0.05$ .

Table 17 - Sums of squares from the analysis of variance for retinol equivalents of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of salt within each gaseous atmosphere

| Source                             | df | FSPF                   | FSPS                  |
|------------------------------------|----|------------------------|-----------------------|
|                                    |    | Sums of squares        |                       |
| Levels of salt within nitrogen gas | 1  | 17579.80 <sup>*</sup>  | 1750.57 <sup>**</sup> |
| Error                              | 88 | 166924.60              | 9693.00               |
| Levels of salt within air          | 1  | 41131.50 <sup>**</sup> | 280.87 <sup>*</sup>   |
| Error                              | 88 | 123476.90              | 4795.75               |

\* Significant at  $P < 0.05$ .

\*\* Significant at  $P < 0.01$ .

RE of chips prepared with FSPF or FSPS and white potato as affected by levels of salt and 2 gaseous atmospheres are presented in Table 18. Salted chips with FSPF as held under nitrogen gas and with FSPS as held under air had higher RE than unsalted chips held under similar atmospheres. Unsalted chips with FSPF held under air and with FSPS held under nitrogen gas had higher RE than salted chips held under similar atmospheres. When held under nitrogen gas, salted chips with FSPF and unsalted chips with FSPS had higher RE. When held under air salted chips with FSPS exhibited the higher RE while RE of unsalted chips with FSPF was higher.

Presented in Table 19 are sums of squares from the analysis of variance for RE of chips prepared with FSPF or FSPS and white potato as affected by 2 gaseous atmospheres within each storage period. Similar information is presented in Table 20 for storage periods within each gaseous atmosphere. Gaseous atmospheres affected RE of chips with FSPF when held for 3, 6 weeks ( $P < 0.05$ ) and 9 weeks ( $P < 0.01$ ) and with FSPS when held for 9 weeks ( $P < 0.05$ ) (Table 19). Storage periods affected ( $P < 0.01$ ) RE of all chips regardless of the gaseous atmosphere of the package.

RE of chips with FSPF or FSPS as affected by storage periods and 2 gaseous atmospheres are presented in Table 21. From 3 to 9 weeks of storage, RE of chips with FSPF was higher when held under nitrogen gas. Chips with FSPS had

Table 18 - Retinol equivalent of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of salt and two gaseous atmospheres

| Levels of Salt                               | Atmosphere                    |                               |
|----------------------------------------------|-------------------------------|-------------------------------|
|                                              | Nitrogen gas                  | Air                           |
| - - - - - RE/100g DWB <sup>a</sup> - - - - - |                               |                               |
| FSPF                                         |                               |                               |
| Salted                                       | d <sup>556</sup> <sup>b</sup> | e <sup>493</sup> <sup>c</sup> |
| Unsalted                                     | e <sup>529</sup> <sup>b</sup> | d <sup>535</sup> <sup>b</sup> |
| FSPS                                         |                               |                               |
| Salted                                       | e <sup>131</sup> <sup>c</sup> | d <sup>137</sup> <sup>b</sup> |
| Unsalted                                     | d <sup>139</sup> <sup>b</sup> | e <sup>133</sup> <sup>c</sup> |

- N = 48.
- a RE/100g DWB indicates grams per 100g calculated on dry weight basis.
- b-c Means within a row followed by a different superscript are significantly different at P<0.05.
- d-e Means a column for each SPF preceded by a different subscript are significantly different at P<0.05.



Table 19 - Sums of squares from the analysis of variance for retinol equivalents of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by two gaseous atmospheres within each storage period

| Source                             | df | FSPF                   | FSPS                 |
|------------------------------------|----|------------------------|----------------------|
|                                    |    | Sums of squares        |                      |
| Gaseous atmospheres within 0 week  | 1  | 534.50 <sup>ns</sup>   | 47.63 <sup>ns</sup>  |
| Error                              | 42 | 59834.80               | 2446.67              |
| Gaseous atmospheres within 3 weeks | 1  | 11045.30 <sup>*</sup>  | 129.72 <sup>ns</sup> |
| Error                              | 42 | 69922.00               | 2872.07              |
| Gaseous atmospheres within 6 weeks | 1  | 11432.00 <sup>*</sup>  | 3.13 <sup>ns</sup>   |
| Error                              | 42 | 90760.30               | 2315.59              |
| Gaseous atmospheres within 9 weeks | 1  | 26435.60 <sup>**</sup> | 444.28 <sup>*</sup>  |
| Error                              | 42 | 120521.70              | 3584.07              |

\* Significant at  $P < 0.05$ .

\*\* Significant at  $P < 0.01$ .

<sup>ns</sup> Not significant at  $P < 0.05$ .

Table 20 - Sums of squares from the analysis of variance for retinol equivalents of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by storage periods within each gaseous atmosphere

| Source                              | df | FSPF            | FSPS      |
|-------------------------------------|----|-----------------|-----------|
|                                     |    | Sums of squares |           |
| Storage periods within nitrogen gas | 3  | 165430.20**     | 1865.34** |
| Error                               | 88 | 166924.60       | 3462.61   |
| Storage periods within air          | 3  | 292205.50**     | 5815.69** |
| Error                               | 88 | 123476.90       | 4795.75   |

\*\* Significant at  $P < 0.01$ .

Table 21 - Retinol equivalent of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by storage periods and two gaseous atmospheres

| Storage, weeks | Atmosphere                                   |                               |
|----------------|----------------------------------------------|-------------------------------|
|                | Nitrogen gas                                 | Air                           |
|                | - - - - - RE/100g DWB <sup>a</sup> - - - - - |                               |
|                | FSPF                                         |                               |
| 0              | d <sup>604</sup> <sup>b</sup>                | d <sup>597</sup> <sup>b</sup> |
| 3              | e <sup>557</sup> <sup>b</sup>                | e <sup>527</sup> <sup>c</sup> |
| 6              | f <sup>514</sup> <sup>b</sup>                | f <sup>483</sup> <sup>c</sup> |
| 9              | f <sup>497</sup> <sup>b</sup>                | g <sup>450</sup> <sup>c</sup> |
|                | FSPS                                         |                               |
| 0              | d <sup>141</sup> <sup>b</sup>                | d <sup>143</sup> <sup>b</sup> |
| 3              | d <sup>138</sup> <sup>b</sup>                | d <sup>141</sup> <sup>b</sup> |
| 6              | e <sup>133</sup> <sup>b</sup>                | e <sup>133</sup> <sup>b</sup> |
| 9              | f <sup>129</sup> <sup>b</sup>                | f <sup>123</sup> <sup>c</sup> |

N = 24.

<sup>a</sup> RE/100g DWB indicates grams per 100g calculated on dry weight basis.

<sup>b-c</sup> Means within a row followed by a different superscript are significantly different at P<0.05.

<sup>d-g</sup> Means in a column for each SPF preceded by a different subscript are significantly different at P<0.05.

higher RE only when held under nitrogen gas during 9 weeks of storage. RE of chips with FSPF decreased with increase in storage periods to 6 weeks when held under nitrogen gas and to 9 weeks when held under air. Chips with FSPS decreased in RE after 3 weeks of storage under both atmospheres.

Sums of squares from the analysis of variance for RE of chips with FSPF or FSPS and white potato as affected by storage periods within each level of salt are presented in Table 22. Table 23 contains similar information for levels of salt within each storage period. Storage period affected ( $P < 0.01$ ) RE of salted and unsalted chips with both types of SPF (Table 22). Levels of salt did not affect RE of chips with either SPF during storage at any period.

RE are present in Table 24 for chips prepared with SPF and white potato as affected by storage periods and levels of salt. RE of salted chips with FSPF decreased as the storage period was extended to 6 weeks while unsalted chips decreased during each period of storage. RE of salted chips with FSPS decreased as the storage period was extended beyond 3 weeks, while unsalted chips showed a decrease in RE between 0, 6 and 9 weeks. Overall, there is no difference between the mean values for RE of salted and unsalted chips of both SPF.

Table 22 - Sums of squares from the analysis of variance for retinol equivalents of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by weeks of storage within each level of salt

| Source                          | df | FSPF            | FSPS      |
|---------------------------------|----|-----------------|-----------|
|                                 |    | Sums of squares |           |
| Storage periods within salted   | 3  | 244944.20**     | 4310.57** |
| Error                           | 88 | 236185.50       | 3827.00   |
| Storage periods within unsalted | 3  | 206539.10**     | 2872.39** |
| Error                           | 88 | 83354.20        | 4974.21   |

\*\* Significant at  $P < 0.01$ .

Table 23 - Sums of squares from the analysis of variance for retinol equivalents of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of salt within each storage period

| Source                        | df | FSPF                  | FSPS                 |
|-------------------------------|----|-----------------------|----------------------|
|                               |    | Sums of squares       |                      |
| Levels of salt within 0 week  | 1  | 59.60 <sup>ns</sup>   | 47.04 <sup>ns</sup>  |
| Error                         | 42 | 59834.80              | 2446.67              |
| Levels of salt within 3 weeks | 1  | 716.50 <sup>ns</sup>  | 0.31 <sup>ns</sup>   |
| Error                         | 42 | 69922.00              | 2872.07              |
| Levels of salt within 6 weeks | 1  | 5391.10 <sup>ns</sup> | 199.96 <sup>ns</sup> |
| Error                         | 42 | 90760.30              | 2315.59              |
| Levels of salt within 9 weeks | 1  | 46.70 <sup>ns</sup>   | 193.64 <sup>ns</sup> |
| Error                         | 42 | 120521.70             | 3584.07              |

<sup>ns</sup> Not significant at  $P < 0.05$ .

Table 24 - Retinol equivalents of chips prepared with flour of sweet potato flesh (FPPF) or skin (FSPS) and white potato as affected by storage periods and levels of salt

| Storage, weeks                         | Levels of Salt                |                                |
|----------------------------------------|-------------------------------|--------------------------------|
|                                        | Salted                        | Unsalted                       |
| - - - - RE/100g DWB <sup>a</sup> - - - |                               |                                |
| FSPF                                   |                               |                                |
| 0                                      | c <sup>602</sup> <sup>b</sup> | c <sup>599</sup> <sup>b</sup>  |
| 3                                      | d <sup>538</sup> <sup>b</sup> | d <sup>546</sup> <sup>b</sup>  |
| 6                                      | e <sup>488</sup> <sup>b</sup> | e <sup>509</sup> <sup>b</sup>  |
| 9                                      | e <sup>472</sup> <sup>b</sup> | f <sup>474</sup> <sup>b</sup>  |
| FSPS                                   |                               |                                |
| 0                                      | c <sup>141</sup> <sup>b</sup> | c <sup>143</sup> <sup>b</sup>  |
| 3                                      | c <sup>139</sup> <sup>b</sup> | cd <sup>140</sup> <sup>b</sup> |
| 6                                      | d <sup>132</sup> <sup>b</sup> | d <sup>136</sup> <sup>b</sup>  |
| 9                                      | e <sup>124</sup> <sup>b</sup> | e <sup>128</sup> <sup>b</sup>  |

N = 24.

a RE/100g DWB indicate grams per 100g calculated on dry weight basis.

b Means within a row followed by a different superscript are significantly different at P<0.05.

c-f Means in a column for each SPF preceded by a different subscript are significantly different at P<0.05.

### Gross Energy:

Sums of squares from the analysis of variance for gross energy of chips prepared with flour of SP and white potato are presented in Table 25. Levels of SP flour affected ( $P<0.01$ ) the gross energy content of all chips.

Presented in Table 26 are the gross energy contents of chips with both SPF and white potato. Chips with FSPF had highest gross energy content at 25% and lowest at 50%. Since no trend was observed, one cannot state with certainty the effect of level of FSPF. As level of FSPS increased, chips exhibited an increase in gross energy at each level.

### Minerals:

Table 27 presents sums of squares from the analysis of variance for mineral contents of chips with FSPF or FSPS and white potato. Levels of FSPF affected ( $P<0.01$ ) calcium, phosphorus, magnesium, potassium and iron contents of chips but had no effect on sodium content. Levels of FSPS affected ( $P<0.01$ ) potassium and iron contents of chips only. Replication affected ( $P<0.01$ ) potassium contents of chips with FSPS.

Presented in Table 28 are mineral contents of chips prepared with FSPF or FSPS and white potato. As levels of FSPF were increased to 50%, calcium, phosphorus, magnesium and potassium contents of chips increased and remained the same from 50 to 100% FSPF levels. The highest level of iron



Table 25 - Sums of squares from the analysis of variance for gross energy of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato

| Source                     | df | FSPF                  | FSPS                   |
|----------------------------|----|-----------------------|------------------------|
| Levels of SPF <sup>a</sup> | 3  | 4476.97 <sup>**</sup> | 53175.15 <sup>**</sup> |
| Replication                | 2  | 202.14 <sup>ns</sup>  | 164.01 <sup>ns</sup>   |
| Error                      | 6  | 429.17                | 866.53                 |

<sup>a</sup> Indicates levels of sweet potato flour.

<sup>\*\*</sup> Significant at  $P < 0.01$ .

<sup>ns</sup> Not significant at  $P < 0.05$ .

Table 26 - Gross energy content of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato

| Levels of SPF <sup>a</sup> % | FSPF                                   | FSPS              |
|------------------------------|----------------------------------------|-------------------|
|                              | - - - - Kj/100g DWB <sup>b</sup> - - - |                   |
| 25                           | 2078 <sup>c</sup>                      | 2252 <sup>f</sup> |
| 50                           | 2025 <sup>e</sup>                      | 2294 <sup>e</sup> |
| 75                           | 2042 <sup>d</sup>                      | 2372 <sup>d</sup> |
| 100                          | 2052 <sup>d</sup>                      | 2424 <sup>c</sup> |

- <sup>a</sup> Percentage sweet potato flour based on amount of white potato flour.
- <sup>b</sup> Kj/100g DWB indicates Kilojoules per 100g calculated on dry weight basis.
- <sup>c-f</sup> Means in a column followed by different superscripts are significantly different at  $P < 0.05$ .

Table 27 - Sums of squares from the analysis of variance for mineral contents of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato

| Source          | df | Calcium | Phosphorus | Magnesium | Potassium | Iron   | Sodium |
|-----------------|----|---------|------------|-----------|-----------|--------|--------|
| Sums of squares |    |         |            |           |           |        |        |
| FSPF            |    |         |            |           |           |        |        |
| Levels of SPF   | 3  | 0.09**  | 0.29**     | 0.04**    | 35.35**   | 0.00** | 0.00ns |
| Replication     | 2  | 0.02ns  | 0.05ns     | 0.00ns    | 0.03ns    | 0.00ns | 0.00ns |
| Error           | 6  | 0.02    | 0.05       | 0.00      | 2.39      | 0.00   | 0.00   |
| FSPS            |    |         |            |           |           |        |        |
| Levels of SPF   | 3  | 0.74ns  | 0.02ns     | 0.03ns    | 15.87**   | 0.00** | 0.00ns |
| Replication     | 2  | 0.19ns  | 0.02ns     | 0.01ns    | 0.40**    | 0.00ns | 0.00ns |
| Error           | 6  | 0.63    | 0.02       | 0.01      | 0.10      | 0.00   | 0.00   |

\*\* Significant at  $P < 0.01$ .  
 ns Not significant at  $P < 0.05$ .

Table 28 - Mineral content of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato

|                     |  | Minerals                                  |                   |                   |                    |                    |                   |
|---------------------|--|-------------------------------------------|-------------------|-------------------|--------------------|--------------------|-------------------|
| Levels of           |  |                                           |                   |                   |                    |                    |                   |
| SPF, % <sup>a</sup> |  | Calcium                                   | Phosphorus        | Magnesium         | Potassium          | Iron               | Sodium            |
|                     |  | - - - - - mg/g DWB <sup>b</sup> - - - - - |                   |                   |                    |                    |                   |
|                     |  | FSPF                                      |                   |                   |                    |                    |                   |
| 25                  |  | 0.91 <sup>d</sup>                         | 1.26 <sup>d</sup> | 0.60 <sup>d</sup> | 10.04 <sup>d</sup> | 0.05 <sup>d</sup>  | 0.46 <sup>c</sup> |
| 50                  |  | 1.10 <sup>c</sup>                         | 1.56 <sup>c</sup> | 0.73 <sup>c</sup> | 13.20 <sup>c</sup> | 0.07 <sup>cd</sup> | 4.49 <sup>c</sup> |
| 75                  |  | 1.06 <sup>c</sup>                         | 1.54 <sup>c</sup> | 0.74 <sup>c</sup> | 13.32 <sup>c</sup> | 0.08 <sup>cd</sup> | 4.49 <sup>c</sup> |
| 100                 |  | 1.14 <sup>c</sup>                         | 1.68 <sup>c</sup> | 0.74 <sup>c</sup> | 14.73 <sup>c</sup> | 0.10 <sup>c</sup>  | 4.47 <sup>c</sup> |
|                     |  | FSPS                                      |                   |                   |                    |                    |                   |
| 25                  |  | 1.99 <sup>c</sup>                         | 1.69 <sup>c</sup> | 0.75 <sup>c</sup> | 12.76 <sup>f</sup> | 0.06 <sup>d</sup>  | 0.46 <sup>c</sup> |
| 50                  |  | 2.43 <sup>c</sup>                         | 1.78 <sup>c</sup> | 0.86 <sup>c</sup> | 14.43 <sup>e</sup> | 0.09 <sup>c</sup>  | 0.46 <sup>c</sup> |
| 75                  |  | 2.61 <sup>c</sup>                         | 1.69 <sup>c</sup> | 0.86 <sup>c</sup> | 15.39 <sup>d</sup> | 0.09 <sup>c</sup>  | 0.47 <sup>c</sup> |
| 100                 |  | 2.60 <sup>c</sup>                         | 1.73 <sup>c</sup> | 0.87 <sup>c</sup> | 15.71 <sup>c</sup> | 0.09 <sup>c</sup>  | 0.48 <sup>c</sup> |

N = 3.  
<sup>a</sup> Percentage sweet potato flour based on amount of white potato flour.  
<sup>b</sup> mg/g DWB indicates milligrams per gram calculated on dry weight basis.  
<sup>c-f</sup> Means in a column for each SPF followed by a different superscript letter are significantly different at P<0.05.

was found at 100% FSPF and sodium content did not change at any level of FSPF. Potassium content of chips prepared with FSPS increased with each increase in level of FSPS, while iron content increased when 50% FSPS was used but remained unchanged at the higher levels. Calcium, phosphorus, magnesium and sodium contents of chips did not change as levels of FSPS increased.

Tables 29 and 30 present sums of squares from the analysis of variance for sodium content of chips with FSPF or FSPS as affected by levels of SPF within each level of salt (Table 29) and levels of salt within each level of SPF (Table 30). Levels of SPF affected ( $P < 0.01$ ) sodium content of salted chips with both SPF but had no effect on unsalted chips. Levels of salt affected ( $P < 0.01$ ) sodium content of chips with FSPF or FSPS at each level of SPF.

Presented in Table 31 is the sodium content of chips as affected by levels of SPF and salt. For salted chips prepared with FSPF, the greatest level of sodium was exhibited at 50% FSPF and lowest at 25%. Salted chips with FSPS increased in sodium content as level of SPF increased to 50% and remained unchanged at other levels. Salted chips in all categories had the greatest sodium content.

#### Peroxide Values:

Sums of squares from the analysis of variance for PV of chips with FSPF or FSPS and white potato are presented in

Table 29 - Sums of squares from the analysis of variance for sodium content of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of sweet potato within each level of salt

| Source                             | df | FSPF                | FSPS               |
|------------------------------------|----|---------------------|--------------------|
|                                    |    | Sums of squares     |                    |
| Levels of SP flour within salted   | 3  | 11.18 <sup>**</sup> | 2.42 <sup>**</sup> |
| Error                              | 4  | 0.05                | 0.03               |
| Levels of SP flour within unsalted | 3  | 0.00 <sup>ns</sup>  | 0.00 <sup>ns</sup> |
| Error                              | 4  | 0.00                | 0.01               |

<sup>\*\*</sup> Significant at  $P < 0.01$ .

<sup>ns</sup> Not significant at  $P < 0.05$ .

Table 30 - Sums of squares from the analysis of variance for sodium content of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of salt within each level of sweet potato

| Source                    | df | FSPF            | FSPS    |
|---------------------------|----|-----------------|---------|
|                           |    | Sums of squares |         |
| Salt within 25% SP flour  | 1  | 26.06**         | 32.09** |
| Error                     | 2  | 0.01            | 0.03    |
| Salt within 50% SP flour  | 1  | 68.72**         | 46.31** |
| Error                     | 2  | 0.01            | 0.00    |
| Salt within 75% SP flour  | 1  | 58.22**         | 48.51** |
| Error                     | 2  | 0.02            | 0.00    |
| Salt within 100% SP flour | 1  | 51.05**         | 48.37** |
| Error                     | 2  | 0.01            | 0.00    |

\*\* Significant at  $P < 0.01$ .

Table 31 - Sodium content of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) as affected by levels of sweet potato and salt

| Levels of Salt           | Levels of sweet potato flour, % <sup>a</sup> |                                |                                |                                |
|--------------------------|----------------------------------------------|--------------------------------|--------------------------------|--------------------------------|
|                          | 25                                           | 50                             | 75                             | 100                            |
| - - - - - mg/g - - - - - |                                              |                                |                                |                                |
| FSPF                     |                                              |                                |                                |                                |
| Salted                   | <sub>f</sub> 5.58 <sup>e</sup>               | <sub>f</sub> 8.73 <sup>b</sup> | <sub>f</sub> 8.10 <sup>c</sup> | <sub>f</sub> 7.62 <sup>d</sup> |
| Unsalted                 | <sub>g</sub> 0.47 <sup>b</sup>               | <sub>g</sub> 0.44 <sup>b</sup> | <sub>g</sub> 0.47 <sup>b</sup> | <sub>g</sub> 0.47 <sup>b</sup> |
| FSPS                     |                                              |                                |                                |                                |
| Salted                   | <sub>f</sub> 6.12 <sup>c</sup>               | <sub>f</sub> 7.27 <sup>b</sup> | <sub>f</sub> 7.43 <sup>b</sup> | <sub>f</sub> 7.45 <sup>b</sup> |
| Unsalted                 | <sub>g</sub> 0.46 <sup>b</sup>               | <sub>g</sub> 0.46 <sup>b</sup> | <sub>g</sub> 0.47 <sup>b</sup> | <sub>g</sub> 0.49 <sup>b</sup> |

- N = 2.
- <sup>a</sup> Percentage sweet potato flour based on white potato flour.
- <sup>b-d</sup> Means within a row followed by a different superscript are significantly different at P<0.05.
- <sup>f-g</sup> Means in a column for each SPF preceded by a different subscript are significantly different at P<0.05.



Table 32. All main factors and their interactions, with two exceptions, affected ( $P < 0.01$  or  $P < 0.05$ ) PV of chips with both SPF. The exceptions were levels of SPF x weeks storage for FSPF and levels of SPF x gaseous atmosphere x salt for FSPS.

Presented in Table 33 are PV of chips with FSPF or FSPS and white potato as affected by levels of SPF, gaseous atmospheres, levels of salt and storage periods. PV of chips with FSPF was similar at 25 and 50% FSPF, increased with 75% and 100% FSPF but did not change at 100% PV increased at each level of FSPS. When held under air chips with both SPF had higher PV than those held under nitrogen gas. Chips held in nitrogen gas atmosphere had PV 23.4% lower in chips with FSPF and 25.0% lower in chips with FSPS. Unsalted chips with FSPF yielded a 7.4% greater PV than salted chips. Likewise, unsalted chips with FSPS yielded an 8.7% greater PV. As storage period increased, PV of chips with both SPF increased at each period. Overall, mean PV at 9 months was 4.2 times greater than for freshly prepared chips. This indicates that chips stored for 9 weeks exhibited more extensive oxidation during storage.

According to this study, the optimum conditions to produce chips with low Pv are; use of 25 or 50% FSPF or 25% FSPS, holding chips under nitrogen gas atmosphere, salting chips and storing for 0 weeks. The PV are relatively low

Table 32 - Sums of squares from the analysis of variance for peroxide values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato

| Source                | df  | FSPF               | FSPS               |
|-----------------------|-----|--------------------|--------------------|
| Level of SPF (L)      | 3   | 27.34**            | 29.23**            |
| Gas (G)               | 1   | 471.37**           | 413.70**           |
| Salt (S)              | 1   | 37.28**            | 41.45**            |
| Weeks of storage (WS) | 3   | 4945.20**          | 3500.55**          |
| L x G                 | 3   | 5.39**             | 15.30**            |
| L x S                 | 3   | 3.06*              | 2.49*              |
| L x WS                | 9   | 5.76 <sup>ns</sup> | 5.95**             |
| G x S                 | 1   | 7.94**             | 6.11**             |
| G x WS                | 3   | 149.20**           | 167.66**           |
| S x WS                | 3   | 9.37**             | 25.21**            |
| L x G x S             | 3   | 3.51*              | 0.88 <sup>ns</sup> |
| L x G x WS            | 9   | 13.66**            | 6.21**             |
| L x S x WS            | 9   | 9.99**             | 6.52**             |
| G x S x WS            | 3   | 4.86**             | 11.38**            |
| L x G x S x WS        | 9   | 8.67**             | 16.00**            |
| Error                 | 128 | 29.00              | 45.00              |

\* Significant at  $P < 0.05$ .

\*\* Significant at  $P < 0.01$ .

<sup>ns</sup> Not significant at  $P < 0.05$ .

Table 33 - Peroxide values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of sweet potato, gaseous atmospheres, levels of salt and storage periods

| Levels of flour, % <sup>a</sup> | Gaseous                     |                             |                             | Storage, weeks     |                             |                                                                                       |
|---------------------------------|-----------------------------|-----------------------------|-----------------------------|--------------------|-----------------------------|---------------------------------------------------------------------------------------|
|                                 | FSPF                        | FSPS                        | Atmosphere                  | FSPF               | FSPS                        | FSPF FSPS                                                                             |
|                                 | meq/kg fat DWB <sup>b</sup> | meq/kg fat DWB <sup>b</sup> | meq/kg fat DWB <sup>b</sup> | Salt               | meq/kg fat DWB <sup>b</sup> | meq/kg fat DWB <sup>b</sup>                                                           |
| 25                              | 11.17 <sup>d</sup>          | 9.73 <sup>f</sup>           | Nitrogen gas                | 10.08 <sup>d</sup> | 8.81 <sup>d</sup>           | Salted 11.20 <sup>d</sup> 9.82 <sup>d</sup> 0 4.23 <sup>f</sup> 3.83 <sup>f</sup>     |
| 50                              | 11.37 <sup>d</sup>          | 10.16 <sup>e</sup>          | Air                         | 13.21 <sup>c</sup> | 11.75 <sup>c</sup>          | Unsalted 12.09 <sup>c</sup> 10.75 <sup>c</sup> 3 10.38 <sup>e</sup> 9.68 <sup>e</sup> |
| 75                              | 11.98 <sup>c</sup>          | 10.43 <sup>d</sup>          |                             |                    |                             | 6 13.89 <sup>d</sup> 12.05 <sup>d</sup>                                               |
| 100                             | 12.05 <sup>c</sup>          | 10.80 <sup>c</sup>          |                             |                    |                             | 9 18.08 <sup>c</sup> 15.56 <sup>c</sup>                                               |

N = 48 for levels of SPF; 96, gaseous atmospheres and levels of salt; 48, storage period.

<sup>a</sup> Percent sweet potato flour based on white potato flour.

<sup>b</sup> meq/kg fat DWB indicates milliequivalents per kg fat calculated on dry weight basis.

<sup>c-f</sup> Means within a column followed by a different superscripts are significantly different at P<0.05.

compared to the PV of 20.5 meq/kg fat for white potato chips after 4 weeks of storage, reported by Han, (1989).

Sums of squares from the analysis of variance of PV for chips with both SPF and white potato as affected by levels of SPF within the 2 gaseous atmospheres are presented in Table 34. Similar information for gaseous atmospheres within each level of SPF is presented in Table 35. Levels of FSPF affected ( $P<0.01$ ) PV of chips held under nitrogen gas or air; levels of FSPS affected ( $P<0.01$ ) PV of chips held under air (Table 34). Gaseous atmospheres affected ( $P<0.01$ ) PV of chips regardless of type and level of SPF.

Presented in Table 36 are PV of chips with FSPF or FSPS and white potato as affected by levels of sweet potato and 2 gaseous atmospheres. PV of chips held under nitrogen gas increased as FSPF increased to 75% with no further increase at 100% FSPF. Chips with FSPS increased in PV as the level of SPF increased, with the exception between 25 and 50%. Chips held under air exhibited a trend for an increase in PV, with PV at 100% SPF being different from the lower levels. Levels of FSPS did not affect PV of chips held under air. Chips held under air had higher PV at every level of both SPF. The mean PV for chips with FSPF was 23.4% higher in chips held under air; and with FSPS, 24.8%.

Sums of squares from the analysis of variance for PV of chips with FSPF or FSPS and white potato as affected by levels of SPF within each storage period are present in

Table 34 - Sums of squares from the analysis of variance for peroxide value of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by level of sweet potato flour within each gaseous atmosphere

| Source                                 | df | FSPF            | FSPS               |
|----------------------------------------|----|-----------------|--------------------|
|                                        |    | Sums of squares |                    |
| Levels of SP flour within nitrogen gas | 3  | 17.83**         | 41.13**            |
| Error                                  | 88 | 32.43           | 59.09              |
| Levels of SP flour within air          | 3  | 14.90**         | 3.40 <sup>ns</sup> |
| Error                                  | 88 | 71.05           | 44.58              |

\*\* Significant at  $P < 0.01$ .

<sup>ns</sup> Not significant at  $P < 0.05$ .

Table 35 - Sums of squares from the analysis of variance for peroxide values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by two gaseous atmospheres within each level of sweet potato

| Source                                 | df | FSPF            | FSPS     |
|----------------------------------------|----|-----------------|----------|
|                                        |    | Sums of squares |          |
| Gaseous atmospheres with 25% SP flour  | 1  | 137.56**        | 138.58** |
| Error                                  | 42 | 80.68           | 65.26    |
| Gaseous atmospheres with 50% SP flour  | 1  | 104.01**        | 148.64** |
| Error                                  | 42 | 71.03           | 75.81    |
| Gaseous atmospheres with 75% SP flour  | 1  | 86.54**         | 87.92**  |
| Error                                  | 42 | 45.99           | 68.37    |
| Gaseous atmospheres with 100% SP flour | 1  | 148.64**        | 53.86**  |
| Error                                  | 42 | 54.10           | 59.59    |

\*\* Significant at  $P < 0.01$ .

Table 36 - Peroxide values of chips prepared with flour sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of sweet potato and two gaseous atmospheres

| Atmosphere                                     | Levels of Sweet Potato Flour, % <sup>a</sup> |                                 |                                  |                                 |
|------------------------------------------------|----------------------------------------------|---------------------------------|----------------------------------|---------------------------------|
|                                                | 25                                           | 50                              | 75                               | 100                             |
| - - - - - meq/kg fatDWB <sup>b</sup> - - - - - |                                              |                                 |                                  |                                 |
| FSPF                                           |                                              |                                 |                                  |                                 |
| Nitrogen gas                                   | <sub>h</sub> 9.48 <sup>e</sup>               | <sub>h</sub> 9.90 <sup>d</sup>  | <sub>h</sub> 10.64 <sup>c</sup>  | <sub>h</sub> 10.29 <sup>c</sup> |
| Air                                            | <sub>g</sub> 12.87 <sup>d</sup>              | <sub>g</sub> 12.85 <sup>d</sup> | <sub>g</sub> 13.32 <sup>cd</sup> | <sub>g</sub> 13.81 <sup>c</sup> |
| FSPS                                           |                                              |                                 |                                  |                                 |
| Nitrogen gas                                   | <sub>h</sub> 8.03 <sup>e</sup>               | <sub>h</sub> 8.40 <sup>e</sup>  | <sub>h</sub> 9.08 <sup>d</sup>   | <sub>h</sub> 9.74 <sup>c</sup>  |
| Air                                            | <sub>g</sub> 11.43 <sup>c</sup>              | <sub>g</sub> 11.92 <sup>c</sup> | <sub>g</sub> 11.78 <sup>c</sup>  | <sub>g</sub> 11.86 <sup>c</sup> |

- N = 24.
- <sup>a</sup> Percentage sweet potato flour based on amount of white potato flour.
- <sup>b</sup> meq/kg fat DWB indicates milliequivalent per kg fat calculated on dry weight basis.
- <sup>c-e</sup> Means within a row followed by a different superscript are significantly different at P<0.05.
- <sup>g-h</sup> Means in a column for each SPF preceded by a different subscript are significantly different at P<0.05.

Table 37. Similar information is presented in Table 38 for storage periods within each level of SPF. Levels of FSPF affected ( $P < 0.01$ ) PV at 3, 6 and 9 weeks storage. PV was affected at ( $P < 0.01$ ) by levels of FSPS at storage periods of 0, 6 and 9 weeks; at 3 weeks, the effect was at  $P < 0.05$  (Table 37). Storage periods affected ( $P < 0.01$ ) PV of all chips at each level of SPF.

PV of chips prepared with both SPF and white potato as affected by levels of SPF and storage periods are presented in Table 39. With exception of chips with FSPF and stored for 0 weeks, there was a trend for an increase in PV as SPF increased. Chips with FSPF had a mean 7.3% greater PV at 100% than at 25% SPF. Similarly, chips with FSPS had a mean 10.4% greater PV at 100% SPF. At each level of FSPF or FSPS, PV increased with storage.

Presented in Table 40 are sums of squares from the analysis of variance for PV of chips with FSPF or FSPS and white potato as affected by levels of SPF within each level of salt. Similar information is presented in Table 41 for levels of salt within each level of SPF. Levels of SPF affected ( $P < 0.01$ ) PV of salted chips with FSPF or FSPS but not on unsalted chips (Table 40). Levels of salt affected ( $P < 0.01$ ) PV of chips with 50 and 100% FSPF and chips with 25% FSPS at  $P < 0.01$  and at the higher levels at  $P < 0.05$ .

PV of chips with both SPF and white potato as affected by levels of sweet potato and salt are presented in Table



Table 37 - Sums of squares from the analysis of variance for peroxide values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of sweet potato within each storage period

| Source                               | df | FSPF                | FSPS                |
|--------------------------------------|----|---------------------|---------------------|
|                                      |    | Sums of squares     |                     |
| Levels of SP flour within<br>0 week  | 3  | 3.07 <sup>ns</sup>  | 1.92 <sup>**</sup>  |
| Error                                | 42 | 33.32               | 4.99                |
| Levels of SP flour within<br>3 weeks | 3  | 8.34 <sup>**</sup>  | 6.19 <sup>*</sup>   |
| Error                                | 42 | 17.71               | 24.12               |
| Levels of SP flour within<br>6 weeks | 3  | 9.43 <sup>**</sup>  | 9.77 <sup>**</sup>  |
| Error                                | 42 | 28.50               | 27.30               |
| Levels of SP flour within<br>9 weeks | 3  | 12.27 <sup>**</sup> | 17.31 <sup>**</sup> |
| Error                                | 42 | 22.45               | 37.21               |

\* Significant at  $P < 0.05$ .

\*\* Significant at  $P < 0.01$ .

ns Not significant at  $P < 0.05$ .

Table 38 - Sums of squares from the analysis of variance for peroxide values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by storage period within each level of sweet potato

| Source                       | df | FSPF           | FSPS     |
|------------------------------|----|----------------|----------|
|                              |    | Sums of square |          |
| Storage within 25% SP flour  | 3  | 119.29**       | 776.31** |
| Error                        | 42 | 80.68          | 65.26    |
| Storage within 50% SP flour  | 3  | 1201.39**      | 858.07** |
| Error                        | 42 | 71.30          | 75.81    |
| Storage within 75% SP flour  | 3  | 1187.36**      | 948.30** |
| Error                        | 42 | 45.99          | 68.34    |
| Storage within 100% SP flour | 3  | 1369.32**      | 923.82** |
| Error                        | 42 | 54.10          | 59.59    |

\*\* Significant at  $P < 0.01$ .

Table 39 - Peroxide values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of sweet potato and storage periods

| Storage, weeks                                  | Levels of FSPS, % <sup>a</sup> |                       |                      |                       |
|-------------------------------------------------|--------------------------------|-----------------------|----------------------|-----------------------|
|                                                 | 25                             | 50                    | 75                   | 100                   |
| - - - - - meq/kg fat DWB <sup>b</sup> - - - - - |                                |                       |                      |                       |
| FSPF                                            |                                |                       |                      |                       |
| 0                                               | h 3.99 <sup>c</sup>            | h 4.03 <sup>c</sup>   | h 4.62 <sup>c</sup>  | h 4.29 <sup>c</sup>   |
| 3                                               | g 9.81 <sup>d</sup>            | g 10.17 <sup>cd</sup> | g 10.87 <sup>c</sup> | g 10.66 <sup>cd</sup> |
| 6                                               | f 13.30 <sup>d</sup>           | f 13.64 <sup>cd</sup> | f 14.24 <sup>c</sup> | f 14.39 <sup>c</sup>  |
| 9                                               | e 17.60 <sup>d</sup>           | e 17.66 <sup>d</sup>  | e 18.18 <sup>d</sup> | e 18.86 <sup>c</sup>  |
| FSPS                                            |                                |                       |                      |                       |
| 0                                               | h 3.60 <sup>d</sup>            | h 3.79 <sup>d</sup>   | h 3.78 <sup>d</sup>  | h 4.15 <sup>c</sup>   |
| 3                                               | g 9.30 <sup>d</sup>            | g 9.51 <sup>cd</sup>  | g 9.67 <sup>cd</sup> | g 10.27 <sup>c</sup>  |
| 6                                               | f 11.38 <sup>d</sup>           | f 11.92 <sup>cd</sup> | f 12.33 <sup>c</sup> | f 12.57 <sup>c</sup>  |
| 9                                               | e 14.65 <sup>e</sup>           | e 15.40 <sup>cd</sup> | e 15.96 <sup>c</sup> | e 16.22 <sup>c</sup>  |

N = 12.

a Percentage sweet potato flour based on amount of white potato flour.

b meq/kg fat DWB indicates milliequivalent per kg fat calculated on dry weight basis.

c-d Means within a row followed by a different superscript are significantly different at P<0.05.

e-h Means in a column for each SPF preceded by a different subscript are significantly different at P<0.05.

Table 40 - Sums of squares from the analysis of variance for peroxide values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of sweet potato within each level of salt

| Source                             | df | FSPF                | FSPS                |
|------------------------------------|----|---------------------|---------------------|
|                                    |    | Sums of squares     |                     |
| Levels of SP flour within salted   | 3  | 16.41 <sup>**</sup> | 23.96 <sup>**</sup> |
| Error                              | 88 | 92.10               | 111.33              |
| Levels of SP flour within unsalted | 3  | 13.99 <sup>*</sup>  | 7.76 <sup>ns</sup>  |
| Error                              | 88 | 153.54              | 147.30              |

<sup>\*\*</sup> Significant at  $P < 0.01$

<sup>ns</sup> Not significant at  $P < 0.05$ .

Table 41 - Sums of squares from the analysis of variance for peroxide values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of salt within each level of sweet potato

| Source                                 | df | FSPF                | FSPS                |
|----------------------------------------|----|---------------------|---------------------|
|                                        |    | Sums of squares     |                     |
| Levels of salt within<br>25% SP flour  | 1  | 6.44 <sup>ns</sup>  | 20.15 <sup>**</sup> |
| Error                                  | 42 | 80.68               | 65.26               |
| Levels of salt within<br>50% SP flour  | 1  | 16.81 <sup>**</sup> | 10.64 <sup>*</sup>  |
| Error                                  | 42 | 70.03               | 75.81               |
| Levels of salt within<br>75% SP flour  | 1  | 3.63 <sup>ns</sup>  | 6.97 <sup>*</sup>   |
| Error                                  | 42 | 45.99               | 68.34               |
| Levels of salt within<br>100% SP flour | 1  | 13.46 <sup>**</sup> | 6.17 <sup>*</sup>   |
| Error                                  | 42 | 54.10               | 59.59               |

\* Significant at  $P < 0.05$ .

\*\* Significant at  $P < 0.01$ .

ns Not significant at  $P < 0.05$ .

42. Salted chips with FSPF had higher PV at 75 and 100% SPF than at the 2 lower levels. Similar chips with FSPS had higher PV at 75 and 100% SPF than at 25% SPF. PV of unsalted chips was not affected by level of either SPF. Salted chips with 50 and 100% FSPF had greater PV than unsalted chips.

Sum of squares from the analysis of variance for PV of chips with FSPF or FSPS and white potato as affected by gaseous atmospheres within levels of salt are presented in Table 43; also, presented in Table 44 are effects of levels of salt within each gaseous atmosphere. PV of salted and unsalted chips with both SPF were affected ( $P < 0.01$ ) by the gaseous atmospheres (Table 43). Levels of salt affected ( $P < 0.01$ ) PV of chips with both SPF held under both gaseous atmospheres.

Presented in Table 45 are PV of chips with both SPF and white potato as affected by levels of salt and 2 gaseous atmospheres. Salted and unsalted chips had greater PV when held under air instead of nitrogen gas. PV were greater for unsalted chips when held under either gaseous atmosphere. These findings indicate that nitrogen gas would be the preferred medium under which to store chips in order to prolong shelf life.

Sums of squares from the analysis of variance for PV of chips with FSPF or FSPS and white potato as affected by 2 gaseous atmospheres within 4 storage periods are presented

Table 42 - Peroxide values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of sweet potato and salt

| Levels of Salt                                  | Levels of Sweet Potato Flour, % <sup>a</sup> |                                  |                                  |                                 |
|-------------------------------------------------|----------------------------------------------|----------------------------------|----------------------------------|---------------------------------|
|                                                 | 25                                           | 50                               | 75                               | 100                             |
| - - - - - meq/kg fat DWB <sup>b</sup> - - - - - |                                              |                                  |                                  |                                 |
| FSPF                                            |                                              |                                  |                                  |                                 |
| Salted                                          | f <sup>10.81</sup> <sup>d</sup>              | g <sup>10.78</sup> <sup>d</sup>  | f <sup>11.70</sup> <sup>c</sup>  | g <sup>11.52</sup> <sup>c</sup> |
| Unsalted                                        | f <sup>11.54</sup> <sup>d</sup>              | f <sup>11.97</sup> <sup>cd</sup> | f <sup>12.25</sup> <sup>cd</sup> | f <sup>12.58</sup> <sup>c</sup> |
| FSPS                                            |                                              |                                  |                                  |                                 |
| Salted                                          | g <sup>9.09</sup> <sup>d</sup>               | g <sup>9.69</sup> <sup>cd</sup>  | g <sup>10.05</sup> <sup>c</sup>  | g <sup>10.44</sup> <sup>c</sup> |
| Unsalted                                        | f <sup>10.38</sup> <sup>c</sup>              | f <sup>10.63</sup> <sup>c</sup>  | f <sup>10.81</sup> <sup>c</sup>  | f <sup>11.16</sup> <sup>c</sup> |

N = 24.

a Percentage sweet potato flour based on amount of white potato flour.

b meq/kg fat DWB indicates milliequivalent per kg fat calculated on dry weight basis.

c-e Means within a row followed by a different superscript are significantly different at P<0.05.

f-g Means in a column for each SPF preceded by a different subscript are significantly different at P<0.05.

Table 43 - Sums of squares from the analysis of variance for peroxide values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by gaseous atmospheres within each level of salt

| Source                              | df | FSPF            | FSPS     |
|-------------------------------------|----|-----------------|----------|
|                                     |    | Sums of squares |          |
| Gaseous atmospheres within salted   | 1  | 178.47**        | 159.62** |
| Error                               | 88 | 92.10           | 111.33   |
| Gaseous atmospheres within unsalted | 1  | 300.84**        | 260.19** |
| Error                               | 88 | 153.54          | 147.30   |

\*\* Significant at  $P < 0.01$ .



Table 44 - Sums of squares from the analysis of variance for peroxide values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of salt within each gaseous atmosphere

| Source                             | df | FSPF            | FSPS    |
|------------------------------------|----|-----------------|---------|
|                                    |    | Sums of squares |         |
| Levels of salt within nitrogen gas | 1  | 5.41**          | 7.86**  |
| Error                              | 88 | 32.43           | 59.09   |
| Levels of salt within air          | 1  | 39.82**         | 39.69** |
| Error                              | 88 | 71.05           | 44.58   |

\*\* Significant at  $P < 0.01$ .

Table 45 - Peroxide values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato flour as affected by levels of salt and two gaseous atmospheres

| Levels of Salt | Atmospheres                             |                      |
|----------------|-----------------------------------------|----------------------|
|                | Nitrogen gas                            | Air                  |
|                | - - meq/kg fat DWB <sup>a</sup> - - - - |                      |
|                | FSPF                                    |                      |
| Salted         | e 9.84 <sup>c</sup>                     | e 12.57 <sup>b</sup> |
| Unsalted       | d 10.31 <sup>c</sup>                    | d 13.86 <sup>b</sup> |
|                | FSPS                                    |                      |
| Salted         | e 8.53 <sup>c</sup>                     | e 11.11 <sup>b</sup> |
| Unsalted       | d 9.10 <sup>c</sup>                     | d 12.39 <sup>b</sup> |

N = 48.

a meq/kg fat DWB indicates milliequivalent per kg fat calculated on dry weight basis.

b-c Means within a row followed by a different superscript are significant different at P<0.05.

d-e Means in a column for each SPF preceded by a different subscript are significantly different at P<0.05.

in Table 46. Similar information for storage periods within each gaseous atmosphere is presented in Table 47. Gaseous atmospheres affected ( $P < 0.01$ ) PV of chips with both SPF during each storage period, except during 0 week (FSPF (Table 46). Storage periods affected ( $P < 0.01$ ) PV of chips prepared with both SPF when held under either gaseous atmosphere (Table 47).

Presented in Table 48 are PV of all chips as affected by storage periods and 2 gaseous atmospheres. Chips with both SPF exhibited higher PV when held under air during each storage period, with the exception of 0 week (FSPF). When held under nitrogen gas or air, chips with FSPF or FSPS and showed an increase in PV as the storage period was extended.

Table 49 presents sums of squares from the analysis of variance for PV of chips with FSPF or FSPS and white potato as affected by levels of salt within storage periods. Similar information for storage periods within levels of salt are presented in Table 50. Levels of salt affected ( $P < 0.01$ ) PV of chips with both SPF during each storage period, except at 3 weeks (Table 49). Storage periods affected ( $P < 0.01$ ) PV of salted and unsalted chips with both SPF (Table 50).

Presented in Table 51 are PV of chips with both SPF and white potato as affected by storage periods and levels of salt. Unsalted chips of FSPF or FSPS had greater PV in each storage period, except for week 3. PV of salted and

Table 46 - Sums of squares from the analysis of variance for peroxide values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by two gaseous atmospheres within each storage period

| Source                             | df | FSPF                 | FSPS                 |
|------------------------------------|----|----------------------|----------------------|
|                                    |    | Sums of squares      |                      |
| Gaseous atmospheres within 0 week  | 1  | 1.73 <sup>ns</sup>   | 3.86 <sup>**</sup>   |
| Error                              | 42 | 33.02                | 4.99                 |
| Gaseous atmospheres within 3 weeks | 1  | 99.62 <sup>**</sup>  | 65.20 <sup>**</sup>  |
| Error                              | 42 | 17.71                | 24.12                |
| Gaseous atmospheres within 6 weeks | 1  | 219.21 <sup>**</sup> | 114.26 <sup>**</sup> |
| Error                              | 42 | 28.50                | 27.30                |
| Gaseous atmospheres within 9 weeks | 1  | 300.00 <sup>**</sup> | 398.03 <sup>**</sup> |
| Error                              | 42 | 22.45                | 37.21                |

<sup>\*\*</sup> Significant at  $P < 0.01$ .

<sup>ns</sup> Not significant at  $P < 0.05$ .

Table 47 - Sums of squares from the analysis of variance for peroxide values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by storage periods within each gaseous atmosphere

| Source                              | df | FSPF            | FSPS      |
|-------------------------------------|----|-----------------|-----------|
|                                     |    | Sums of squares |           |
| Storage periods within nitrogen gas | 3  | 1699.68**       | 1094.82** |
| Error                               | 88 | 32.43           | 59.09     |
| Storage periods within air          | 3  | 3394.73**       | 2573.39** |
| Error                               | 88 | 71.05           | 44.58     |

\*\* Significant at  $P < 0.01$ .

Table 48 - Peroxide values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato flour as affected by storage periods and two gaseous atmospheres

| Storage, weeks | Atmospheres                             |                      |
|----------------|-----------------------------------------|----------------------|
|                | Nitrogen gas                            | Air                  |
|                | - - - meq/kg fat DWB <sup>a</sup> - - - |                      |
|                | FSPF                                    |                      |
| 0              | g 4.04 <sup>b</sup>                     | g 4.42 <sup>b</sup>  |
| 3              | f 8.94 <sup>c</sup>                     | f 11.82 <sup>b</sup> |
| 6              | e 11.76 <sup>c</sup>                    | e 16.03 <sup>b</sup> |
| 9              | d 15.58 <sup>c</sup>                    | d 20.58 <sup>b</sup> |
|                | FSPS                                    |                      |
| 0              | g 3.55 <sup>c</sup>                     | g 4.12 <sup>b</sup>  |
| 3              | f 8.52 <sup>c</sup>                     | f 10.85 <sup>b</sup> |
| 6              | e 10.51 <sup>c</sup>                    | e 13.59 <sup>b</sup> |
| 9              | d 12.68 <sup>c</sup>                    | d 18.44 <sup>b</sup> |

N = 24.

<sup>a</sup> meq/kg fat DWB indicates milliequivalents per kg fat calculated on dry weight basis.

<sup>b-c</sup> Means within a row followed by a different superscript are significantly different at P<0.05.

<sup>d-g</sup> Means in a column for each SPF preceded by a different subscript are significantly different at P<0.05.

Table 49 - Sums of squares from the analysis of variance for peroxide values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of salt within each storage period

| Source                           | df | FSPF               | FSPS               |
|----------------------------------|----|--------------------|--------------------|
|                                  |    | Sums of squares    |                    |
| Levels of salt within<br>0 week  | 1  | 5.27**             | 3.21**             |
| Error                            | 42 | 33.00              | 5.00               |
| Levels of salt within<br>3 weeks | 1  | 0.99 <sup>ns</sup> | 0.04 <sup>ns</sup> |
| Error                            | 42 | 18.00              | 24.00              |
| Levels of salt within<br>6 weeks | 1  | 15.31**            | 35.05**            |
| Error                            | 42 | 28.00              | 27.00              |
| Levels of salt within<br>9 weeks | 1  | 25.09**            | 28.67**            |
| Error                            | 42 | 22.00              | 37.00              |

\*\* Significant at  $P < 0.01$ .

<sup>ns</sup> Not significant at  $P < 0.05$ .

Table 50 - Sums of squares from the analysis of variance for peroxide values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by storage periods within each level of salt

| Source                         | df | FSPF            | FSPS      |
|--------------------------------|----|-----------------|-----------|
|                                |    | Sums of squares |           |
| Storage periods within salted  | 3  | 2319.75**       | 1573.92** |
| Error                          | 88 | 92.10           | 111.33    |
| Storage periods within unsaltd | 3  | 2634.82**       | 1952.13** |
| Error                          | 88 | 153.54          | 147.30    |

\*\* Significant at  $P < 0.01$ .



Table 51 - Peroxide values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by storage periods and levels of salt

| Storage, weeks | Salt                                      |                      |
|----------------|-------------------------------------------|----------------------|
|                | Salted                                    | Unsalted             |
|                | - - - - meq/kg fat DWB <sup>a</sup> - - - |                      |
|                | FSPF                                      |                      |
| 0              | g 3.90 <sup>c</sup>                       | g 4.56 <sup>b</sup>  |
| 3              | f 10.23 <sup>b</sup>                      | f 10.52 <sup>b</sup> |
| 6              | e 13.33 <sup>c</sup>                      | e 14.46 <sup>b</sup> |
| 9              | d 17.35 <sup>c</sup>                      | d 18.80 <sup>b</sup> |
|                | FSPS                                      |                      |
| 0              | g 3.57 <sup>c</sup>                       | g 4.09 <sup>b</sup>  |
| 3              | f 9.71 <sup>b</sup>                       | f 9.66 <sup>b</sup>  |
| 6              | e 11.20 <sup>c</sup>                      | e 12.90 <sup>b</sup> |
| 9              | d 14.79 <sup>c</sup>                      | d 16.33 <sup>b</sup> |

N = 24.

a meq/kg fat DWB indicates milliequivalents per kg fat calculated on dry weight basis.

b-c Means within a row followed by a different superscript are significantly different at P<0.05.

d-g Means in a column for each SPF preceded by a different subscript are significantly different at P<0.05.

unsalted chips with both SPF increased with an extended storage period. Unsalted chips with FSPF had a mean PV 7% greater than the PV for salted chips. Likewise, unsalted chips with FSPS had a mean PV 0.9% greater. Overall increase in PV was similar among the 4 sets of samples; the mean increase was 4.2-fold.

## B. Physical Tests

### Firmness Analysis:

Sums of squares from the analysis of variance for firmness of chips prepared with FSPF or FSPS and white potato are presented in Table 52. Levels of SPF (FSPF and FSPS), storage periods and interaction level of FSPF x salt level affected chip firmness at  $P < 0.01$ . Gaseous atmospheres (FSPF and FSPS) and interaction levels of FSPF x gaseous atmospheres affected firmness at  $P < 0.05$ .

Firmness of chips with both SPF and white potato as affected by levels of SPF, gaseous atmospheres, levels of salt and storage periods are presented in Table 53. As levels of FSPF increased, firmness of chips increased. Chips with FSPF were firmer than chips with FSPS. Chips prepared with 100% FSPF were 1.9 times firmer than chips with 25% FSPF. In comparison, chips with 100% FSPS were 1.3 times firmer than chips with 25% FSPS. Air-stored chips were firmer than nitrogen gas-stored chips. Levels of salt

Table 52 - Sums of squares from the analysis of variance for firmness of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato

| Source                | df  | FSPF                   | FSPS                  |
|-----------------------|-----|------------------------|-----------------------|
| Level of SPF (L)      | 3   | 4873684.80**           | 444900.56**           |
| Gas (G)               | 1   | 16968.90*              | 5177.13*              |
| Salt (S)              | 1   | 484.50 <sup>ns</sup>   | 163.17 <sup>ns</sup>  |
| Weeks of storage (WS) | 3   | 1324.30 <sup>ns</sup>  | 19629.31**            |
| L x G                 | 3   | 24236.80*              | 7110.56 <sup>ns</sup> |
| L x S                 | 3   | 33121.20**             | 7169.52 <sup>ns</sup> |
| L x WS                | 9   | 10797.00 <sup>ns</sup> | 2755.42 <sup>ns</sup> |
| G x S                 | 1   | 4456.40 <sup>ns</sup>  | 49.01 <sup>ns</sup>   |
| G x WS                | 3   | 3726.40 <sup>ns</sup>  | 337.64 <sup>ns</sup>  |
| S x WS                | 3   | 5323.30 <sup>ns</sup>  | 592.43 <sup>ns</sup>  |
| L x G x S             | 3   | 15678.50 <sup>ns</sup> | 7097.02 <sup>ns</sup> |
| L x G x WS            | 9   | 30065.80 <sup>ns</sup> | 972.09 <sup>ns</sup>  |
| L x S x WS            | 9   | 1985.50 <sup>ns</sup>  | 3252.30 <sup>ns</sup> |
| G x S x WS            | 3   | 3638.90 <sup>ns</sup>  | 164.93 <sup>ns</sup>  |
| L x G x S x WS        | 9   | 10157.40 <sup>ns</sup> | 2943.13 <sup>ns</sup> |
| Error                 | 128 | 2744.90                | 146853.00             |

\* Significant at  $P < 0.05$ .

\*\* Significant at  $P < 0.01$ .

<sup>ns</sup> Not significant at  $P < 0.05$ .



did not affect firmness. Storage period did not affect firmness of chips with FSPF. Chips with FSPS increased firmness at the 2 longest storage periods.

Presented in Table 54 are sums of squares from the analysis of variance for firmness of chips with FSPF or FSPS and white potato as affected by levels of SPF within each gaseous atmosphere. Similar information is presented in Table 55 for gaseous atmospheres within each level of SPF. Levels of SPF affected ( $P < 0.01$ ) firmness of chips prepared with either SPF and held under either gaseous atmosphere (Table 54). Gaseous atmospheres affected chips with FSPF at 25% level at  $P < 0.01$  and at 50% level at  $P < 0.05$ . The atmosphere over the chips with FSPS affected ( $P < 0.05$ ) firmness at 25 and 100% levels of SPF.

Firmness of chips with FSPF or FSPS and white potato as affected by levels of SPF and 2 gaseous atmospheres are presented in Table 56. All chips held under nitrogen gas and chips with FSPF held under nitrogen gas increased in firmness at each successive increase in SPF. Firmness of chips with 50, 75 and 100% FSPS when held under nitrogen gas had similar firmness that was greater than firmness of chips with 25% FSPF. In one-half of the sets of samples firmness was greater for chips held under air than for chips held under nitrogen. For the remaining sets of samples, no difference in firmness was found between the 2 atmospheres.

Table 54 - Sums of squares from the analysis of variance for firmness of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of sweet potato within each gaseous atmosphere

| Source                                 | df | FSPF            | FSPS        |
|----------------------------------------|----|-----------------|-------------|
|                                        |    | Sums of squares |             |
| Levels of SP flour within nitrogen gas | 1  | 2504185.21**    | 184749.77** |
| Error                                  | 88 | 441924.20       | 158935.85   |
| Levels of SP flour within air          | 1  | 2013077.60**    | 180963.33** |
| Error                                  | 88 | 400852.40       | 99161.67    |

\*\* Significant at  $P < 0.01$ .

Table 55 - Sums of squares from the analysis of variance for firmness of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by gaseous atmospheres within each level of sweet potato

| Source                               | df | FSPF                  | FSPS                 |
|--------------------------------------|----|-----------------------|----------------------|
|                                      |    | Sums of squares       |                      |
| Gaseous atmospheres 25%<br>SP flour  | 1  | 29254.69**            | 7008.33*             |
| Error                                | 42 | 59484.38              | 41308.33             |
| Gaseous atmospheres 50%<br>SP flour  | 1  | 8138.02*              | 858.52 <sup>ns</sup> |
| Error                                | 42 | 69017.71              | 35627.88             |
| Gaseous atmospheres 75%<br>SP flour  | 1  | 1938.02 <sup>ns</sup> | 918.75 <sup>ns</sup> |
| Error                                | 42 | 227788.54             | 57637.50             |
| Gaseous atmospheres 100%<br>SP flour | 1  | 1875.00 <sup>ns</sup> | 3502.08*             |
| Error                                | 42 | 70091.67              | 27687.50             |

\* Significant at  $P < 0.05$ .

\*\* Significant at  $P < 0.01$ .

<sup>ns</sup> Not significant at  $P < 0.05$ .

Table 56 - Firmness of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of sweet potato flour and two gaseous atmospheres

| Atmospheres                     | Levels of sweet potato flour, % <sup>a</sup> |                   |                   |                   |
|---------------------------------|----------------------------------------------|-------------------|-------------------|-------------------|
|                                 | 25                                           | 50                | 75                | 100               |
| - - - - - grams force - - - - - |                                              |                   |                   |                   |
| FSPF                            |                                              |                   |                   |                   |
| Nitrogen gas                    | g <sup>446e</sup>                            | g <sup>704d</sup> | f <sup>820c</sup> | f <sup>889b</sup> |
| Air                             | f <sup>495e</sup>                            | f <sup>730d</sup> | f <sup>807c</sup> | f <sup>902b</sup> |
| FSPS                            |                                              |                   |                   |                   |
| Nitrogen gas                    | g <sup>350c</sup>                            | f <sup>458b</sup> | f <sup>461b</sup> | g <sup>480b</sup> |
| Air                             | f <sup>374e</sup>                            | f <sup>450d</sup> | f <sup>470c</sup> | f <sup>497b</sup> |

- N = 24.
- a Percentage sweet potato flour based on amount of white potato flour.
- b-e Means within a row followed by a different superscripts are significantly different at P<0.05.
- f-g Means in a column for each SPF preceded by a different subscript are significantly different at P<0.05.



Table 57 presents sums of squares from the analysis of variance for firmness of chips with FSPF or FSPS and white potato as affected by levels of SPF within each storage period. Similar information is presented in Table 58 for storage periods within each level of SPF. Levels of SPF affected ( $P < 0.01$ ) firmness of chips with both SPF during each storage period (Table 57). Firmness of chips was affected ( $P < 0.05$ ) by storage period when only 50% FSPS was used (Table 58).

Presented in Table 59 are firmness values of chips with FSPF or FSPS and white potato as affected by levels of SPF and storage periods. Chips became firmer as levels of SPF increased during each storage period. Not all increases were significant. Chips with 100% FSPF had a mean firmness of 1.9 times greater than firmness of chips with 25% FSPF. Likewise, chips with 100% FSPS were 1.3 times firmer. Chips at all levels of FSPF or FSPS did not change firmness as storage period increased, except chips with 50% FSPF during 0 week storage.

Sums of squares from the analysis of variance for firmness of chips with both SPF and white potato as affected by levels of SPF within each level of salt are presented in Table 60 and levels of salt within each level of SPF are presented in Table 61. Levels of FSPF and FSPS affected ( $P < 0.01$ ) firmness of salted and unsalted chips (Table 60).

Table 57 - Sums of squares from the analysis of variance of firmness of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) with white potato as affected by levels of sweet potato flour within each storage period

| Source                            | df | FSPF            | FSPS        |
|-----------------------------------|----|-----------------|-------------|
|                                   |    | Sums of squares |             |
| Levels of SP flour within 0 week  | 3  | 1206630.70**    | 120283.33** |
| Error                             | 42 | 66896.90        | 34008.33    |
| Levels of SP flour within 3 weeks | 3  | 1300139.60**    | 114291.67** |
| Error                             | 42 | 69487.50        | 51758.33    |
| Levels of SP flour within 6 weeks | 3  | 1184355.70**    | 107656.25** |
| Error                             | 42 | 86588.50        | 42370.83    |
| Levels of SP flour within 9 weeks | 3  | 1193355.70**    | 105424.73** |
| Error                             | 42 | 251717.70       | 47473.71    |

\*\* Significant at  $P < 0.01$ .

Table 58 - Sums of squares from the analysis of variance of firmness of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) with white potato as affected by storage periods within each level of sweet potato flour

| Source                       | df | FSPF                  | FSPS                  |
|------------------------------|----|-----------------------|-----------------------|
|                              |    | Sums of squares       |                       |
| Storage within 25% SP flour  | 3  | 4218.23 <sup>ns</sup> | 6216.67 <sup>ns</sup> |
| Error                        | 42 | 59484.38              | 41308.33              |
| Storage within 50% SP flour  | 3  | 2293.23 <sup>ns</sup> | 8805.56 <sup>*</sup>  |
| Error                        | 42 | 69017.71              | 35627.88              |
| Storage within 75% SP flour  | 3  | 2384.90 <sup>ns</sup> | 4872.92 <sup>ns</sup> |
| Error                        | 42 | 227788.54             | 57637.50              |
| Storage within 100% SP flour | 3  | 3225.00 <sup>ns</sup> | 2489.58 <sup>ns</sup> |
| Error                        | 42 | 70091.67              | 7687.50               |

\* Significant at  $P < 0.05$ .

<sup>ns</sup> Not significant at  $P < 0.05$ .

Table 59 - Firmness of chips prepared with flour of sweet potato flesh (FSPF) or skin ((FSPS) and white potato as affected by levels of sweet potato flour and storage periods

| Storage, weeks                  | Levels of sweet potato flour, % <sup>a</sup> |                   |                    |                   |
|---------------------------------|----------------------------------------------|-------------------|--------------------|-------------------|
|                                 | 25                                           | 50                | 75                 | 100               |
| - - - - - grams force - - - - - |                                              |                   |                    |                   |
| FSPF                            |                                              |                   |                    |                   |
| 0                               | f <sup>472e</sup>                            | f <sup>728d</sup> | f <sup>816c</sup>  | f <sup>893b</sup> |
| 3                               | f <sup>456e</sup>                            | f <sup>718d</sup> | f <sup>823c</sup>  | f <sup>888b</sup> |
| 6                               | f <sup>474e</sup>                            | f <sup>712d</sup> | f <sup>811c</sup>  | f <sup>893b</sup> |
| 9                               | f <sup>482e</sup>                            | f <sup>711d</sup> | f <sup>803c</sup>  | f <sup>909b</sup> |
| FSPS                            |                                              |                   |                    |                   |
| 0                               | f <sup>346d</sup>                            | g <sup>432c</sup> | f <sup>453c</sup>  | f <sup>479b</sup> |
| 3                               | f <sup>358c</sup>                            | f <sup>456b</sup> | f <sup>459b</sup>  | f <sup>486b</sup> |
| 6                               | f <sup>367c</sup>                            | f <sup>466b</sup> | f <sup>468b</sup>  | f <sup>488b</sup> |
| 9                               | f <sup>377d</sup>                            | f <sup>464c</sup> | f <sup>480bc</sup> | f <sup>499b</sup> |

N = 12.

a Percentage sweet potato flour based on white potato flour.

b-e Means within a row followed by a different superscript are significantly different at P<0.05.

f-g Means in a column for each SPF followed by a different subscript are significantly different at P<0.05.

Table 60 - Sums of squares from the analysis of variance for firmness of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of sweet potato within each level of salt

| Source                             | df | FSPF            | FSPS        |
|------------------------------------|----|-----------------|-------------|
|                                    |    | Sums of squares |             |
| Levels of SP flour within salted   | 1  | 2336650.80**    | 218153.12** |
| Error                              | 88 | 156039.60       | 103983.33   |
| Levels of SP flour within unsalted | 1  | 2570155.20**    | 233916.95** |
| Error                              | 88 | 295596.90       | 67502.42    |

\*\* Significant at  $P < 0.01$ .

Table 61 - Sums of squares from the analysis of variance for firmness of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of salt within each level of sweet potato

| Source                                 | df | FSPF                   | FSPS                  |
|----------------------------------------|----|------------------------|-----------------------|
|                                        |    | Sums of squares        |                       |
| Levels of salt within<br>25% SP flour  | 1  | 42.18 <sup>ns</sup>    | 133.33 <sup>ns</sup>  |
| Error                                  | 42 | 59484.38               | 41308.33              |
| Levels of salt within<br>50% SP flour  | 1  | 22750.52 <sup>**</sup> | 3978.52 <sup>*</sup>  |
| Error                                  | 42 | 69017.71               | 35627.88              |
| Levels of salt within<br>75% SP flour  | 1  | 13.02 <sup>ns</sup>    | 3168.75 <sup>ns</sup> |
| Error                                  | 42 | 227788.54              | 57637.50              |
| Levels of salt within<br>100% SP flour | 1  | 10800.00 <sup>*</sup>  | 52.08 <sup>ns</sup>   |
| Error                                  | 42 | 70091.67               | 27687.50              |

\* Significant at  $P < 0.05$ .

\*\* Significant at  $P < 0.01$ .

ns Not significant at  $P < 0.05$ .

Levels of salt affected firmness of chips with 50% FSPF at  $P < 0.01$  and with 50% FSPS and 100% FSPF at  $P < 0.05$  (Table 61).

Firmness of chips with FSPF or FSPS and white potato as affected by levels of SPF and salt are presented in Table 62. Salted and unsalted chips became firmer as the level of SPF increased, although the increased firmness was not significant at every successive increase of SPF. In 1 set of samples (100% FSPF) firmness was greater for unsalted chips. In 2 sets of samples (50% FSPF and 50% FSPS) firmness was lower for unsalted chips.

Table 63 presents sums of squares from the analysis of variance for firmness of chips prepared with both SPF and white potato as affected by gaseous atmospheres within each level of salt. Similar information is presented in Table 64 for levels of salt within each gaseous atmosphere. Gaseous atmospheres affected firmness of salted chips with FSPF ( $P < 0.01$ ) and unsalted chips with FSPS ( $P < 0.05$ ) (Table 63). Levels of salt did not affect firmness of chips from the 2 gaseous atmospheres (Table 64).

Firmness of chips with both SPF and white potato as affected by levels of salt and gaseous atmospheres are presented in Table 65. Salted chips with FSPF and unsalted chips with FSPS were firmer when held under air. Firmness for the 2 other sets of samples was not affected by atmosphere. The level of salt had no effect on firmness within a particular atmosphere.



Table 62 - Firmness of chips prepared with flour of sweet potato as flesh (FSPF) or skin (FSPS) and white potato as affected by levels of sweet potato flour and salt

| Levels of Salt                  | Levels of sweet potato flour % <sup>a</sup> |                    |                    |                    |
|---------------------------------|---------------------------------------------|--------------------|--------------------|--------------------|
|                                 | 25                                          | 50                 | 75                 | 100                |
| - - - - - grams force - - - - - |                                             |                    |                    |                    |
| FSPF                            |                                             |                    |                    |                    |
| Salted                          | f <sup>470</sup> e                          | f <sup>739</sup> d | f <sup>814</sup> c | g <sup>880</sup> b |
| Unsalted                        | f <sup>471</sup> e                          | g <sup>696</sup> d | f <sup>813</sup> c | f <sup>910</sup> b |
| FSPS                            |                                             |                    |                    |                    |
| Salted                          | f <sup>363</sup> d                          | f <sup>463</sup> c | f <sup>457</sup> c | f <sup>489</sup> b |
| Unsalted                        | f <sup>360</sup> d                          | g <sup>445</sup> c | f <sup>473</sup> b | f <sup>487</sup> b |

- N = 24.
- <sup>a</sup> Percentage sweet potato flour based on amount of white potato flour.
- <sup>b-e</sup> Means within a row followed by a different superscript are significantly different at P<0.05.
- <sup>f-g</sup> Means in a column for each SPF preceded by a different subscript are significantly different at P<0.05.



Table 63 - Sums of squares from the analysis of variance of firmness of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) with white potato as affected by gaseous atmospheres within each level of salt

| Source                              | df | FSPF                  | FSPS                  |
|-------------------------------------|----|-----------------------|-----------------------|
|                                     |    | Sum of squares        |                       |
| Gaseous atmospheres within salted   | 1  | 19408.60**            | 2109.37 <sup>ns</sup> |
| Error                               | 88 | 156039.60             | 103983.33             |
| Gaseous atmospheres within unsalted | 1  | 2016.70 <sup>ns</sup> | 3116.76*              |
| Error                               | 88 | 295596.90             | 67502.42              |

\* Significant at  $P < 0.05$ .

\*\* Significant at  $P < 0.01$ .

<sup>ns</sup> Not significant at  $P < 0.05$ .

Table 64 - Sums of squares from the analysis of variance of the firmness of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) with white potato as affected by levels of salt within each gaseous atmosphere

| Source                   | df | FSPF                  | FSPS                 |
|--------------------------|----|-----------------------|----------------------|
|                          |    | Sums of squares       |                      |
| Salt within nitrogen gas | 1  | 1001.00 <sup>ns</sup> | 195.51 <sup>ns</sup> |
| Error                    | 88 | 216757.30             | 92082.83             |
| Salt within air          | 1  | 3939.80 <sup>ns</sup> | 16.67 <sup>ns</sup>  |
| Error                    | 88 | 245360.40             | 79716.67             |

<sup>ns</sup> Not significant at  $P < 0.05$ .

Table 65 - Firmness of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) with white potato as affected by levels of salt and gaseous atmosphere

| Levels of salt        | Atmospheres                   |                               |
|-----------------------|-------------------------------|-------------------------------|
|                       | Nitrogen gas                  | Air                           |
| - - - grams force - - |                               |                               |
| FSPF                  |                               |                               |
| Salted                | <sub>c</sub> 712 <sup>b</sup> | <sub>c</sub> 740 <sup>a</sup> |
| Unsalted              | <sub>c</sub> 718 <sup>a</sup> | <sub>c</sub> 727 <sup>a</sup> |
| FSPS                  |                               |                               |
| Salted                | <sub>c</sub> 439 <sup>a</sup> | <sub>c</sub> 448 <sup>a</sup> |
| Unsalted              | <sub>c</sub> 436 <sup>b</sup> | <sub>c</sub> 447 <sup>a</sup> |

- N = 48.
- a-b Means within a row followed by a different superscript are significantly different at P<0.05.
- c Means in a column for each SPF followed by a different subscript are significantly different at P<0.05.

Sums of squares from the analysis of variance for firmness of chips with both SPF and white potato as affected by 2 gaseous atmospheres within each storage periods are presented in Table 66. Similar information for storage periods within each gaseous atmospheres is presented in Table 67. Gaseous atmospheres affected ( $P < 0.05$ ) firmness of chips with FSPF only (Table 66). Firmness of chips prepared with FSPS was affected during storage under nitrogen gas and air (Table 67).

Presented in Table 68 are firmness values of chips with FSPF or FSPS and white potato as affected by storage periods and 2 gaseous atmospheres. At 6 weeks of storage, chips with FSPF held under air were firmer. Firmness of all other chips during each storage period did not change when held under either gaseous atmosphere. Chips with FSPF held under both gaseous atmospheres did not change as storage periods were extended. However, chips with FSPS became firmer when stored for 9 weeks under both gaseous atmospheres.

Table 69 presents sums of squares from the analysis of variance for firmness of chips with FSPF or FSPS as affected by levels of salt within each storage period. Similar information is presented in Table 70 for storage periods within each level of salt. Levels of salt did not affect firmness of chips (Table 69). Storage periods affected ( $P < 0.05$ ) firmness of salted and unsalted chips with FSPS but not FSPF.

Table 66 - Sums of squares from the analysis of variance of firmness of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) with white potato as affected by two gaseous atmospheres within each storage period

| Source                             | df | FSPF                  | FSPS                  |
|------------------------------------|----|-----------------------|-----------------------|
|                                    |    | Sums of squares       |                       |
| Gaseous atmospheres within 0 week  | 1  | 567.20 <sup>ns</sup>  | 2408.33 <sup>ns</sup> |
| Error                              | 42 | 66896.90              | 34008.33              |
| Gaseous atmospheres within 3 weeks | 1  | 5002.10 <sup>ns</sup> | 533.33 <sup>ns</sup>  |
| Error                              | 42 | 69487.50              | 51758.33              |
| Gaseous atmospheres within 6 weeks | 1  | 11875.50 <sup>*</sup> | 1302.08 <sup>ns</sup> |
| Error                              | 42 | 86588.50              | 42370.83              |
| Gaseous atmospheres within 9 weeks | 1  | 3250.50 <sup>ns</sup> | 1271.02 <sup>ns</sup> |
| Error                              | 42 | 251717.70             | 47473.71              |

\* Significant at  $P < 0.01$ .

<sup>ns</sup> Not significant at  $P < 0.05$ .

Table 67 - Sums of squares from the analysis of variance  
firmness of chips prepared with flour of sweet potato flesh  
(FSPF) or skin (FSPS) with white potato as affected by  
storage periods within each gaseous atmosphere

| Source                         | df | FSPF                  | FSPS                  |
|--------------------------------|----|-----------------------|-----------------------|
|                                |    | Sums of squares       |                       |
| Storage within nitrogen<br>gas | 3  | 4235.40 <sup>ns</sup> | 11108.61 <sup>*</sup> |
| Error                          | 88 | 216757.30             | 92082.83              |
| Storage within air             | 3  | 815.40 <sup>ns</sup>  | 8858.33 <sup>*</sup>  |
| Error                          | 88 | 245360.40             | 79716.67              |

\* Significant at  $P < 0.05$ .

<sup>ns</sup> Not significant at  $P < 0.05$ .

Table 68 - Firmness of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) with white potato as affected by storage periods and two gaseous atmospheres

| Storage, weeks          | Atmospheres                    |                                |
|-------------------------|--------------------------------|--------------------------------|
|                         | Nitrogen gas                   | Air                            |
| - - - grams force - - - |                                |                                |
| FSPF                    |                                |                                |
| 0                       | c <sup>724</sup> <sup>a</sup>  | c <sup>731</sup> <sup>a</sup>  |
| 3                       | c <sup>711</sup> <sup>a</sup>  | c <sup>731</sup> <sup>a</sup>  |
| 6                       | c <sup>706</sup> <sup>b</sup>  | c <sup>738</sup> <sup>a</sup>  |
| 9                       | c <sup>718</sup> <sup>a</sup>  | c <sup>735</sup> <sup>a</sup>  |
| FSPS                    |                                |                                |
| 0                       | d <sup>420</sup> <sup>a</sup>  | d <sup>435</sup> <sup>a</sup>  |
| 3                       | cd <sup>436</sup> <sup>a</sup> | cd <sup>443</sup> <sup>a</sup> |
| 6                       | cd <sup>442</sup> <sup>a</sup> | cd <sup>453</sup> <sup>a</sup> |
| 9                       | c <sup>450</sup> <sup>a</sup>  | c <sup>460</sup> <sup>a</sup>  |

- N = 24.
- a-b Means within a row followed by a different superscript are significantly different  $P < 0.05$ .
- c-d Means in a column for each SPF followed by a different subscript are significantly different at  $P < 0.05$ .

Table 69 - Sums of squares from the analysis of variance of firmness of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of salt within storage period

| Source              | df | FSPF                  | FSPS                 |
|---------------------|----|-----------------------|----------------------|
|                     |    | Sums of squares       |                      |
| Salt within 0 week  | 1  | 3250.50 <sup>ns</sup> | 0.00 <sup>ns</sup>   |
| Error               | 42 | 66896.90              | 34008.33             |
| Salt within 3 weeks | 1  | 18.70 <sup>ns</sup>   | 8.33 <sup>ns</sup>   |
| Error               | 42 | 69487.50              | 51758.33             |
| Salt within 6 weeks | 1  | 1575.50 <sup>ns</sup> | 18.75 <sup>ns</sup>  |
| Error               | 42 | 86588.50              | 42370.83             |
| Salt within 9 weeks | 1  | 963.00 <sup>ns</sup>  | 728.52 <sup>ns</sup> |
| Error               | 42 | 25171.77              | 47473.71             |

<sup>ns</sup> Not significant at  $P < 0.05$ .



Table 70 - Sums of squares from the analysis of variance of firmness of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by storage periods within each level of salt

| Source                  | df | FSPF                  | FSPS                  |
|-------------------------|----|-----------------------|-----------------------|
|                         |    | Sums of squares       |                       |
| Storage within salted   | 3  | 5617.40 <sup>ns</sup> | 12253.12 <sup>*</sup> |
| Error                   | 88 | 156039.60             | 10398.33              |
| Storage within unsalted | 3  | 1030.20 <sup>ns</sup> | 7968.61 <sup>*</sup>  |
| Error                   | 88 | 295596.90             | 67502.42              |

\* Significant at  $P < 0.05$ .

<sup>ns</sup> Not significant at  $P < 0.05$ .

Firmness values of chips with FSPF or FSPS and white potato as affected by storage periods and levels of salt are presented in Table 71. Firmness of salted and unsalted chips of both SPF and each storage period was not different. Extending storage periods of both salted and unsalted chips with FSPS affected firmness, but not chips with FSPF.

#### Color Analysis:

Sums of squares from the analysis of variance for Hunter L, 'a' and 'b' values of chips with FSPF or FSPS and white potato are presented in Tables 72 (FSPF) and 73 (FSPS). The main factors and their interactions affected ( $P < 0.01$ ) Hunter L, 'a' and 'b' values of chips with FSPF, except gaseous atmospheres (Hunter 'b') and the interaction levels of salt x storage period (Hunter L). Hunter L, 'a' and 'b' values of chips with FSPS were affected ( $P < 0.01$ ) by all the main factors and their one-way interactions, except the interactions of gaseous atmosphere x storage periods (Hunter 'a'), levels of SPF x storage periods and levels of salt x storage periods (Hunter 'b').

Hunter L, 'a' and 'b' values of chips with both SPF and white potato as affected by levels of SPF, gaseous atmospheres, levels of salt and storage periods are presented in Tables 74 (FSPF) and 75 (FSPS). As levels of FSPF increased, Hunter L values of chips decreased and Hunter 'a' and 'b' values increased (Table 74). These color

Table 71 - Firmness of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by storage periods and levels of salt

| Storage, weeks          | Salt                           |                                |
|-------------------------|--------------------------------|--------------------------------|
|                         | Salted                         | Unsalted                       |
| - - - grams force - - - |                                |                                |
| FSPF                    |                                |                                |
| 0                       | b <sup>735</sup> <sup>a</sup>  | b <sup>719</sup> <sup>a</sup>  |
| 3                       | b <sup>720</sup> <sup>a</sup>  | b <sup>722</sup> <sup>a</sup>  |
| 6                       | b <sup>716</sup> <sup>a</sup>  | b <sup>728</sup> <sup>a</sup>  |
| 9                       | b <sup>731</sup> <sup>a</sup>  | b <sup>722</sup> <sup>a</sup>  |
| FSPS                    |                                |                                |
| 0                       | c <sup>428</sup> <sup>a</sup>  | c <sup>428</sup> <sup>a</sup>  |
| 3                       | bc <sup>440</sup> <sup>a</sup> | bc <sup>439</sup> <sup>a</sup> |
| 6                       | bc <sup>447</sup> <sup>a</sup> | b <sup>448</sup> <sup>a</sup>  |
| 9                       | b <sup>459</sup> <sup>a</sup>  | b <sup>451</sup> <sup>a</sup>  |

N = 24.

a Means within a row followed by a different superscript are significantly different at  $P < 0.05$ .

b-c Means in a column for each SPF followed by a different subscript are significantly different at  $P < 0.05$ .

Table 72 - Sums of squares from the analysis of variance for Hunter color measurements of chips prepared with flour of sweet potato flesh (FSPF) and white potato

| Source                | df  | L                  | 'a'      | 'b'                |
|-----------------------|-----|--------------------|----------|--------------------|
| Level of FSPF (L)     | 3   | 2780.31**          | 865.04** | 49.34**            |
| Gas (G)               | 1   | 100.78**           | 105.32** | 0.06 <sup>ns</sup> |
| Salt (S)              | 1   | 23.03**            | 1.02**   | 170.82**           |
| Weeks of storage (WS) | 3   | 107.17**           | 23.18**  | 30.49**            |
| L x G                 | 3   | 106.99**           | 18.61**  | 37.33**            |
| L x S                 | 3   | 49.88**            | 14.67**  | 41.09**            |
| L x WS                | 9   | 23.64**            | 7.43**   | 13.37**            |
| G x S                 | 1   | 25.74**            | 8.25**   | 45.34**            |
| G x WS                | 3   | 18.42**            | 2.48**   | 45.78**            |
| S x WS                | 3   | 1.26 <sup>ns</sup> | 1.96**   | 2.06**             |
| L x G x S             | 3   | 44.98**            | 15.13**  | 47.14**            |
| L x G x WS            | 9   | 20.63**            | 3.68**   | 5.89**             |
| L x S x WS            | 9   | 36.42**            | 2.38**   | 6.61**             |
| G x S x WS            | 3   | 25.79**            | 2.81**   | 7.01**             |
| L x G x S x WS        | 9   | 45.64**            | 3.28**   | 21.75**            |
| Error                 | 128 | 25.57              | 3.54     | 13.69              |

\* Significant at  $P < 0.05$ .

\*\* Significant at  $P < 0.01$ .

<sup>ns</sup> Not significant at  $P < 0.05$ .

Table 73 - Sums of squares from the analysis of variance for Hunter color measurements of chips prepared with flour of sweet potato skin (FSPS) and white potato

| Source                | df  | L                  | 'a'                | 'b'                |
|-----------------------|-----|--------------------|--------------------|--------------------|
| Level of FSPS (L)     | 3   | 1075.84**          | 429.51**           | 260.93**           |
| Gas (G)               | 1   | 12.76**            | 6.64**             | 102.38**           |
| Salt (S)              | 1   | 152.83**           | 5.64**             | 217.60**           |
| Weeks of storage (WS) | 3   | 272.63**           | 66.96**            | 164.28**           |
| L x G                 | 3   | 60.62**            | 3.73**             | 124.93**           |
| L x S                 | 3   | 33.88**            | 2.83**             | 20.12**            |
| L x WS                | 9   | 16.87**            | 9.52**             | 9.27 <sup>ns</sup> |
| G x S                 | 1   | 293.78**           | 4.85**             | 150.52**           |
| G x WS                | 3   | 52.48**            | 0.77 <sup>ns</sup> | 10.85**            |
| S x WS                | 3   | 26.92**            | 8.95**             | 1.50 <sup>ns</sup> |
| L x G x S             | 3   | 21.01**            | 2.27**             | 60.97**            |
| L x G x WS            | 9   | 14.46**            | 3.43**             | 7.41 <sup>ns</sup> |
| L x S x WS            | 9   | 6.39 <sup>ns</sup> | 1.91*              | 9.38 <sup>ns</sup> |
| G x S x WS            | 3   | 16.94**            | 2.13**             | 1.39 <sup>ns</sup> |
| L x G x S x WS        | 9   | 7.17 <sup>ns</sup> | 4.27**             | 4.36 <sup>ns</sup> |
| Error                 | 128 | 62.77              | 12.90              | 91.37              |

\* Significant at  $P < 0.05$ .

\*\* Significant at  $P < 0.05$ .

<sup>ns</sup> Not significant at  $P < 0.05$ .

Table 74 - Hunter L, 'a' and 'b' values of chips prepared with flour of sweet potato flesh (FSPF) and white potato as affected by levels of sweet potato, gaseous atmosphere, levels of salt and storage periods

| Levels of flour, % <sup>a</sup> | Atmospheres or Salt level |                    |                    |              | Storage, weeks     |                    |                    |   |                    |                                       |
|---------------------------------|---------------------------|--------------------|--------------------|--------------|--------------------|--------------------|--------------------|---|--------------------|---------------------------------------|
|                                 | L                         | 'a'                | 'b'                | Atmosphere   | L                  | 'a'                | 'b'                | L | 'a'                | 'b'                                   |
| 25                              | 57.93 <sup>b</sup>        | 7.78 <sup>e</sup>  | 25.61 <sup>e</sup> | Nitrogen gas | 52.84 <sup>c</sup> | 10.88 <sup>b</sup> | 25.99 <sup>c</sup> | 0 | 52.50 <sup>e</sup> | 10.68 <sup>b</sup> 26.57 <sup>b</sup> |
| 50                              | 56.00 <sup>c</sup>        | 8.93 <sup>d</sup>  | 25.56 <sup>d</sup> | Air          | 54.29 <sup>b</sup> | 9.40 <sup>c</sup>  | 26.03 <sup>b</sup> | 3 | 53.37 <sup>d</sup> | 10.19 <sup>c</sup> 26.21 <sup>c</sup> |
| 75                              | 52.39 <sup>d</sup>        | 10.42 <sup>c</sup> | 26.05 <sup>c</sup> | Salt level   | 53.22 <sup>c</sup> | 10.21 <sup>b</sup> | 26.95 <sup>b</sup> | 6 | 53.85 <sup>c</sup> | 9.94 <sup>d</sup> 25.63 <sup>d</sup>  |
| 100                             | 47.95 <sup>e</sup>        | 13.44 <sup>b</sup> | 26.82 <sup>b</sup> | Salted       | 53.91 <sup>b</sup> | 10.07 <sup>c</sup> | 25.07 <sup>c</sup> | 9 | 54.55 <sup>b</sup> | 9.76 <sup>e</sup> 25.63 <sup>d</sup>  |

N = 48 for level of SPF; 96, gaseous atmospheres and levels of salt; 48, storage period.

<sup>a</sup> Percentage sweet potato flour based on white potato flour.

b-e Means within a column followed by a different superscript are significantly different at P<0.05.

Table 75 - Hunter L, 'a' and 'b' values of chips prepared with flour of skin (FSPS) and white potato as affected by levels of sweet potato, gaseous atmospheres, levels of salt and storage periods

| Levels of flour, % <sup>a</sup> | Atmospheres        |                    |                    |              | Storage, weeks     |                    |                    |   |
|---------------------------------|--------------------|--------------------|--------------------|--------------|--------------------|--------------------|--------------------|---|
|                                 | L                  | 'a'                | 'b'                | Atmosphere   | L                  | 'a'                | 'b'                |   |
| 25                              | 49.79 <sup>b</sup> | 8.38 <sup>d</sup>  | 24.50 <sup>e</sup> | Nitrogen gas | 46.67 <sup>c</sup> | 10.57 <sup>b</sup> | 27.20 <sup>b</sup> | 0 |
|                                 |                    |                    |                    |              | 45.44 <sup>e</sup> | 11.17 <sup>b</sup> | 25.31 <sup>e</sup> |   |
| 50                              | 48.36 <sup>c</sup> | 9.85 <sup>c</sup>  | 26.75 <sup>d</sup> | Air          | 47.67 <sup>b</sup> | 10.22 <sup>c</sup> | 25.74 <sup>c</sup> | 3 |
|                                 |                    |                    |                    |              | 46.27 <sup>d</sup> | 10.71 <sup>c</sup> | 25.96 <sup>d</sup> |   |
| 75                              | 45.98 <sup>d</sup> | 10.85 <sup>b</sup> | 27.09 <sup>c</sup> | Salt level   | 47.82 <sup>b</sup> | 10.22 <sup>c</sup> | 27.53 <sup>b</sup> | 6 |
|                                 |                    |                    |                    | Salted       | 47.38 <sup>c</sup> | 10.03 <sup>d</sup> | 26.81 <sup>c</sup> |   |
| 100                             | 43.57 <sup>e</sup> | 9.65 <sup>d</sup>  | 27.52 <sup>b</sup> | Unsalted     | 46.03 <sup>c</sup> | 10.56 <sup>b</sup> | 25.40 <sup>c</sup> | 9 |
|                                 |                    |                    |                    |              | 48.61 <sup>b</sup> | 9.65 <sup>e</sup>  | 27.78 <sup>b</sup> |   |

N = 48 for levels of SPF; 96, gaseous atmospheres and levels of salt; 48, storage periods.

<sup>a</sup> Percentage sweet potato flour based on white potato.

b-e Means within a column followed by a different superscript are significantly different at p<0.05.



changes indicate that the overall color of the chips became darker and more orange as FSPF increased. This phenomenon may be attributed to increased beta-carotene which contributes to color of SP chips (Hoover, 1963). When stored under air atmosphere, chips were lighter as indicated by Hunter L, less red (Hunter 'a') and yellower (Hunter 'b') than chips stored under nitrogen gas. This finding indicates that nitrogen gas would be preferred as the medium under which chips could be held to preserve color of chips. Unsalted chips were lighter and less red and yellow than salted chips. The Hunter values were slightly different, thus one may not be able to make a visible distinction between the 2 samples. As storage was extended, chips became lighter and less red and yellow. Chips with FSPS became lighter, redder (up to 75% FSPS) and yellower as levels of FSPS increased (Table 75). Color of chips held under nitrogen gas were darker, redder and yellower, a more desirable color than the color of chips held under air. Unsalted chips were darker, redder and less yellow than salted chips. As storage was extended, chips became lighter, less red and more yellow. As with chips with FSPF, the relatively small color differences may not have been of such magnitude to permit one to make visual distinction.

Table 76 presents sums of squares from the analysis of variance for Hunter color values of all chips as affected by levels of SP within each gaseous atmosphere. Similar



Table 76 - Sums of squares from the analysis of variance for Hunter L, 'a' and 'b' values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of sweet potato within each gaseous atmosphere

| Source                                 | df | FSPF            | FSPS     |
|----------------------------------------|----|-----------------|----------|
|                                        |    | Sums of squares |          |
|                                        |    | Hunter L        |          |
| Levels of SP flour within nitrogen gas | 3  | 1086.91**       | 367.33** |
| Error                                  | 88 | 46.73           | 89.11    |
| Levels of SP flour within air          | 3  | 1645.02**       | 725.21** |
| Error                                  | 88 | 382.46          | 161.22   |
|                                        |    | Hunter 'a'      |          |
| Levels of SP flour within nitrogen gas | 3  | 485.01**        | 250.71** |
| Error                                  | 88 | 34.71           | 29.76    |
| Levels of SP flour within air          | 3  | 341.21**        | 178.61** |
| Error                                  | 88 | 77.59           | 22.38    |
|                                        |    | Hunter 'b'      |          |
| Levels of SP flour within nitrogen gas | 3  | 34.78**         | 323.08** |
| Error                                  | 88 | 92.37           | 94.44    |
| Levels of SP flour within air          | 3  | 10.12**         | 6.72**   |
| Error                                  | 88 | 108.01          | 167.39   |

\*\* Significant at  $P < 0.01$ .

ns Not significant at  $P < 0.05$ .

information is presented in Table 77 for gaseous atmospheres within each level of SPF. Hunter L, 'a' and 'b' values of chips with both SPF were affected ( $P < 0.01$ ) by levels of SPF when held under both gaseous atmospheres (Table 76). Gaseous atmospheres affected Hunter L, 'a' and 'b' values of chips in 16 of the 24 sample sets (Table 77). The greater number of samples with changes applied to chips prepared with FSPF.

Hunter L, 'a' and 'b' values of chips with FSPF or FSPS and white potato as affected by levels of SPF and 2 gaseous atmospheres are presented in Tables 78 (FSPF) and 79 (FSPS). Chips with FSPF and FSPS held under nitrogen or air atmospheres became darker, with one exception (25 to 50% FSPS), became redder (Hunter 'a') and yellower (Hunter 'b') with increased levels of SPF. Chips with FSPF of both atmospheres became darker (Hunter L), with one exception (25 and 50% FSPS, nitrogen gas), redder and yellower. Thus color became more orange (Table 78). The same statement may be made for chips with FSPF (Table 79). For practically all samples with both SPF, chips held under nitrogen gas retained the 3 color attributes to a greater degree than holding under air (Table 78 and 79); consequently, chips held under nitrogen gas were darker, redder and slightly, if not more, yellower.

Presented in Tables 80 and 81 are sums of squares from the analysis of variance for Hunter color values of chips

Table 77 - Sums of squares from the analysis of variance for Hunter L, 'a' and 'b' values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by gaseous atmospheres within each level of sweet potato

| Source                                  | df | FSPF                | FSPS                |
|-----------------------------------------|----|---------------------|---------------------|
| Sums of squares                         |    |                     |                     |
| Hunter L                                |    |                     |                     |
| Gaseous atmosphere within 25% SP flour  | 1  | 24.23 <sup>**</sup> | 67.69 <sup>**</sup> |
| Error                                   | 42 | 31.11               | 65.06               |
| Gaseous atmosphere within 50% SP flour  | 1  | 77.78 <sup>**</sup> | 0.07 <sup>ns</sup>  |
| Error                                   | 42 | 25.92               | 183.15              |
| Gaseous atmosphere within 75% SP flour  | 1  | 94.36 <sup>**</sup> | 4.88 <sup>ns</sup>  |
| Error                                   | 42 | 47.56               | 127.23              |
| Gaseous atmosphere within 100% SP flour | 1  | 11.41 <sup>ns</sup> | 0.75 <sup>ns</sup>  |
| Error                                   | 42 | 139.87              | 126.47              |
| Hunter 'a'                              |    |                     |                     |
| Gaseous atmosphere within 25% SP flour  | 1  | 2.85 <sup>**</sup>  | 0.08 <sup>ns</sup>  |
| Error                                   | 42 | 5.94                | 3.33                |
| Gaseous atmosphere within 50% SP flour  | 1  | 40.15 <sup>**</sup> | 2.52 <sup>**</sup>  |
| Error                                   | 42 | 5.88                | 9.69                |

Table 77 continued

|                                            |    |                    |                    |
|--------------------------------------------|----|--------------------|--------------------|
| Gaseous atmosphere within<br>75% SP flour  | 1  | 55.26**            | 2.30**             |
| Error                                      | 42 | 6.60               | 9.66               |
| Gaseous atmosphere within<br>100% SP flour | 1  | 25.67**            | 5.47**             |
| Error                                      | 42 | 25.08              | 18.80              |
| Hunter 'b'                                 |    |                    |                    |
| Gaseous atmosphere within<br>25% SP flour  | 1  | 15.53*             | 2.21 <sup>ns</sup> |
| Error                                      | 42 | 96.15              | 30.90              |
| Gaseous atmosphere within<br>50% SP flour  | 1  | 1.96 <sup>ns</sup> | 0.54 <sup>ns</sup> |
| Error                                      | 42 | 44.50              | 61.64              |
| Gaseous atmosphere within<br>75% SP flour  | 1  | 16.10**            | 81.38**            |
| Error                                      | 42 | 22.49              | 124.51             |
| Gaseous atmosphere within<br>100% SP flour | 1  | 3.80*              | 143.18**           |
| Error                                      | 42 | 32.14              | 120.70             |

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\* Significant at  $P < 0.05$ .

\*\* Significant at  $P < 0.01$ .

<sup>ns</sup> Not significant at  $P < 0.05$ .

Table 78 - Hunter L, 'a' and 'b' values of chips prepared with flour of sweet potato flesh and white potato as affected by levels of sweet potato and two gaseous atmospheres

| Gaseous Atmospheres | Levels of FSPF, % <sup>a</sup>  |                                 |                                 |                                 |
|---------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
|                     | 25                              | 50                              | 75                              | 100                             |
| Hunter L            |                                 |                                 |                                 |                                 |
| Nitrogen gas        | <sub>g</sub> 57.22 <sup>b</sup> | <sub>g</sub> 54.73 <sup>c</sup> | <sub>g</sub> 50.98 <sup>d</sup> | <sub>f</sub> 48.44 <sup>e</sup> |
| Air                 | <sub>f</sub> 58.64 <sup>b</sup> | <sub>f</sub> 57.28 <sup>c</sup> | <sub>f</sub> 53.79 <sup>d</sup> | <sub>f</sub> 47.46 <sup>e</sup> |
| Hunter 'a'          |                                 |                                 |                                 |                                 |
| Nitrogen gas        | <sub>f</sub> 8.02 <sup>e</sup>  | <sub>f</sub> 9.84 <sup>d</sup>  | <sub>f</sub> 11.50 <sup>c</sup> | <sub>f</sub> 14.17 <sup>b</sup> |
| Air                 | <sub>g</sub> 7.53 <sup>e</sup>  | <sub>g</sub> 8.01 <sup>d</sup>  | <sub>g</sub> 9.35 <sup>c</sup>  | <sub>g</sub> 12.71 <sup>b</sup> |
| Hunter 'b'          |                                 |                                 |                                 |                                 |
| Nitrogen gas        | <sub>g</sub> 25.04 <sup>d</sup> | <sub>f</sub> 25.76 <sup>c</sup> | <sub>f</sub> 26.63 <sup>b</sup> | <sub>g</sub> 26.54 <sup>b</sup> |
| Air                 | <sub>f</sub> 26.18 <sup>c</sup> | <sub>f</sub> 25.36 <sup>d</sup> | <sub>g</sub> 25.48 <sup>d</sup> | <sub>f</sub> 27.10 <sup>b</sup> |

- N = 24.
- <sup>a</sup> Percentage sweet potato flour based on amount of white potato flour.
- <sup>b-e</sup> Means within a row followed by a different superscript are significantly different at P<0.05.
- <sup>f-g</sup> Means in a column for Hunter L, 'a' and 'b' values preceded by a different subscript are significantly different at P<0.05.

Table 79 - Hunter L 'a' and 'b' values of chips prepared with flour of sweet potato skin (FSPS) and white potato as affected by levels of sweet potato flour and two gaseous atmospheres

| Gaseous<br>Atmospheres | Levels of FSPS, % <sup>a</sup>  |                                 |                                 |                                 |
|------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
|                        | 25                              | 50                              | 75                              | 100                             |
| Hunter L               |                                 |                                 |                                 |                                 |
| Nitrogen gas           | <sub>g</sub> 48.60 <sup>b</sup> | <sub>f</sub> 48.32 <sup>b</sup> | <sub>f</sub> 46.30 <sup>c</sup> | <sub>f</sub> 43.45 <sup>d</sup> |
| Air                    | <sub>f</sub> 50.98 <sup>b</sup> | <sub>f</sub> 48.40 <sup>c</sup> | <sub>f</sub> 45.66 <sup>d</sup> | <sub>f</sub> 43.70 <sup>e</sup> |
| Hunter 'a'             |                                 |                                 |                                 |                                 |
| Nitrogen gas           | <sub>f</sub> 8.33 <sup>e</sup>  | <sub>f</sub> 10.08 <sup>d</sup> | <sub>f</sub> 11.07 <sup>c</sup> | <sub>f</sub> 12.82 <sup>b</sup> |
| Air                    | <sub>f</sub> 8.42 <sup>e</sup>  | <sub>f</sub> 9.62 <sup>d</sup>  | <sub>g</sub> 10.63 <sup>c</sup> | <sub>g</sub> 12.15 <sup>b</sup> |
| Hunter 'b'             |                                 |                                 |                                 |                                 |
| Nitrogen gas           | <sub>f</sub> 24.29 <sup>e</sup> | <sub>f</sub> 26.86 <sup>d</sup> | <sub>f</sub> 28.39 <sup>c</sup> | <sub>f</sub> 29.25 <sup>b</sup> |
| Air                    | <sub>f</sub> 24.72 <sup>c</sup> | <sub>f</sub> 26.65 <sup>b</sup> | <sub>g</sub> 25.79 <sup>b</sup> | <sub>g</sub> 25.79 <sup>b</sup> |

- N = 24.
- a Percentage sweet potato flour based on amount of white potato flour.
- b-e Means within a row followed by a different superscript are significantly different at P<0.05.
- f-g Means in a column for Hunter L, 'a' and 'b' values preceded by a different subscript are significantly different at P<0.05.

Table 80 - Sums of squares from the analysis of variance for Hunter L, 'a' and 'b' values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of sweet potato within each storage period

| Source                            | df | FSPF     | FSPS     |
|-----------------------------------|----|----------|----------|
| Sums of squares                   |    |          |          |
| Hunter L                          |    |          |          |
| Levels of SP flour within 0 week  | 3  | 612.79** | 356.69** |
| Error                             | 42 | 16.73    | 76.51    |
| Levels of SP flour within 3 weeks | 3  | 593.58** | 299.16** |
| Error                             | 42 | 29.28    | 114.62   |
| Levels of SP flour within 6 weeks | 3  | 820.49** | 239.38** |
| Error                             | 42 | 87.14    | 171.19   |
| Levels of SP flour within 9 weeks | 3  | 777.10** | 197.48** |
| Error                             | 42 | 248.50   | 154.71   |
| Hunter 'a'                        |    |          |          |
| Levels of SP flour within 0 week  | 3  | 283.08** | 150.74** |
| Error                             | 42 | 12.70    | 5.79     |
| Levels of SP flour within 3 weeks | 3  | 214.88** | 118.63** |
| Error                             | 42 | 18.82    | 14.88    |
| Levels of SP flour within 6 weeks | 3  | 191.48** | 88.49**  |
| Error                             | 42 | 17.66    | 8.91     |

Table 80 continued

|                                      |    |                      |                     |
|--------------------------------------|----|----------------------|---------------------|
| Levels of SP flour within<br>9 week  | 3  | 183.08 <sup>**</sup> | 81.17 <sup>**</sup> |
| Error                                | 42 | 23.16                | 8.74                |
| Hunter 'b'                           |    |                      |                     |
| Levels of SP flour within<br>0 week  | 3  | 31.84 <sup>**</sup>  | 66.21 <sup>**</sup> |
| Error                                | 42 | 25.25                | 110.04              |
| Levels of SP flour within<br>3 weeks | 3  | 11.84 <sup>ns</sup>  | 74.98 <sup>**</sup> |
| Error                                | 42 | 66.06                | 96.46               |
| Levels of SP flour within<br>6 weeks | 3  | 2.87 <sup>ns</sup>   | 67.83 <sup>**</sup> |
| Error                                | 42 | 82.44                | 111.89              |
| Levels of SP flour within<br>9 weeks | 3  | 16.15 <sup>**</sup>  | 61.17 <sup>**</sup> |
| Error                                | 42 | 52.11                | 152.06              |

<sup>\*\*</sup> Significant at  $P < 0.01$ .

<sup>ns</sup> Not significant at  $P < 0.05$ .



Table 81 - Sums of squares from the analysis of variance for Hunter L, 'a' and 'b' values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) as affected by storage periods within each level of sweet potato

| Source                       | df | FSPF               | FSPS     |
|------------------------------|----|--------------------|----------|
| Sums of squares              |    |                    |          |
| Hunter L                     |    |                    |          |
| Storage within 25% SP flour  | 3  | 31.29**            | 34.08**  |
| Error                        | 42 | 31                 | 65       |
| Storage within 50% SP flour  | 3  | 43.95**            | 59.91**  |
| Error                        | 42 | 26                 | 183      |
| Storage within 75% SP flour  | 3  | 47.42**            | 79.54**  |
| Error                        | 42 | 48                 | 127      |
| Storage within 100% SP flour | 3  | 8.15 <sup>ns</sup> | 115.97** |
| Error                        | 42 | 140                | 126      |
| Hunter 'a'                   |    |                    |          |
| Storage within 25% SP flour  | 3  | 0.70 <sup>ns</sup> | 4.63**   |
| Error                        | 42 | 6                  | 3        |
| Storage within 50% SP flour  | 3  | 2.65**             | 10.26**  |
| Error                        | 42 | 6                  | 10       |
| Storage within 75% SP flour  | 3  | 9.49**             | 32.95**  |
| Error                        | 42 | 7                  | 10       |
| Storage within 100% SP flour | 3  | 17.76**            | 28.65**  |
| Error                        | 42 | 25                 | 19       |
| Hunter 'b'                   |    |                    |          |
| Storage within 25% SP flour  | 3  | 1.11 <sup>ns</sup> | 42.40**  |
| Error                        | 42 | 96                 | 31       |
| Storage within 50% SP flour  | 3  | 3.96 <sup>ns</sup> | 48.49**  |
| Error                        | 42 | 44                 | 62       |

Table 81 continued

|                              |    |                     |                     |
|------------------------------|----|---------------------|---------------------|
| Storage within 75% SP flour  | 3  | 19.41 <sup>**</sup> | 55.95 <sup>**</sup> |
| Error                        | 42 | 22                  | 125                 |
| Storage within 100% SP flour | 3  | 19.38 <sup>**</sup> | 26.71 <sup>*</sup>  |
| Error                        | 42 | 32                  | 121                 |

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\* Significant at  $P < 0.05$ .

\*\* Significant at  $P < 0.01$ .

ns Not significant at  $P < 0.05$ .

with FSPF or FSPS and white potato as affected by levels of SPF within each storage period (Table 80) and storage periods within each level of SPF (Table 81). Levels of both SPF affected ( $P < 0.01$ ) Hunter L, 'a' and 'b' values of chips stored for each period, except Hunter 'b' values of chips with FSPF stored 3 and 6 weeks (Table 80). Storage periods affected Hunter L ( $P < 0.01$ ), except chips with 100% FSPF, Hunter 'b' ( $P < 0.01$ ), except chips with 25% FSPF, and Hunter 'b' ( $P < 0.01$  or  $P < 0.05$ ), except chips with 25 or 50% FSPF (Table 81).

Hunter L, 'a' and 'b' values of chips with FSPF or FSPS and white potato as affected by levels of SPF and storage periods are presented in Tables 82 (FSPF) and 83 (FSPS). Where significant, chips of both SPF became darker (change to lower Hunter L), redder (change to greater Hunter 'a') and yellower (change to greater Hunter 'b'). These changes were of such magnitude that color perception was possible by the human eye.

Sums of squares from the analysis of variance for Hunter color values of chips with all SPF and white potato as affected by levels of SPF within each level of salt are presented in Table 84. Similar information for levels of salt within each level of SPF are presented in Table 85. Levels of both SPF affected ( $P < 0.01$ ) Hunter L, 'a' and 'b' values of salted and unsalted chips. In 18 cases, levels of salt affected Hunter L, 'a' ( $P < 0.01$ ) and 'b' ( $P < 0.01$  and

Table 82 - Hunter L, 'a' and 'b' values of chips prepared with flour of sweet potato flesh (FSPF) and white potato as affected by levels of sweet potato flour and storage periods

| Storage, weeks | Levels of FSPF, % <sup>a</sup>  |                                 |                                 |                                 |
|----------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
|                | 25                              | 50                              | 75                              | 100                             |
| Hunter L       |                                 |                                 |                                 |                                 |
| 0              | <sub>h</sub> 56.83 <sup>b</sup> | <sub>i</sub> 54.66 <sup>c</sup> | <sub>i</sub> 51.08 <sup>d</sup> | <sub>f</sub> 47.43 <sup>e</sup> |
| 3              | <sub>g</sub> 57.52 <sup>b</sup> | <sub>h</sub> 55.64 <sup>c</sup> | <sub>h</sub> 51.96 <sup>d</sup> | <sub>f</sub> 48.36 <sup>e</sup> |
| 6              | <sub>f</sub> 58.53 <sup>b</sup> | <sub>g</sub> 56.48 <sup>c</sup> | <sub>g</sub> 52.73 <sup>d</sup> | <sub>f</sub> 47.66 <sup>e</sup> |
| 9              | <sub>f</sub> 58.86 <sup>b</sup> | <sub>f</sub> 57.23 <sup>c</sup> | <sub>f</sub> 53.78 <sup>d</sup> | <sub>f</sub> 48.35 <sup>e</sup> |
| Hunter 'a'     |                                 |                                 |                                 |                                 |
| 0              | <sub>f</sub> 7.93 <sup>e</sup>  | <sub>f</sub> 9.31 <sup>d</sup>  | <sub>f</sub> 11.08 <sup>c</sup> | <sub>f</sub> 14.42 <sup>b</sup> |
| 3              | <sub>f</sub> 7.87 <sup>e</sup>  | <sub>g</sub> 8.92 <sup>d</sup>  | <sub>g</sub> 10.50 <sup>c</sup> | <sub>g</sub> 13.48 <sup>b</sup> |
| 6              | <sub>f</sub> 7.68 <sup>e</sup>  | <sub>g</sub> 8.80 <sup>d</sup>  | <sub>g</sub> 10.28 <sup>c</sup> | <sub>g</sub> 13.01 <sup>b</sup> |
| 9              | <sub>f</sub> 7.64 <sup>e</sup>  | <sub>g</sub> 8.68 <sup>d</sup>  | <sub>h</sub> 9.84 <sup>c</sup>  | <sub>g</sub> 12.86 <sup>b</sup> |
| Hunter 'b'     |                                 |                                 |                                 |                                 |
| 0              | <sub>f</sub> 25.69 <sup>d</sup> | <sub>f</sub> 25.93 <sup>d</sup> | <sub>f</sub> 26.93 <sup>c</sup> | <sub>f</sub> 27.73 <sup>b</sup> |
| 3              | <sub>f</sub> 25.81 <sup>b</sup> | <sub>f</sub> 25.74 <sup>b</sup> | <sub>g</sub> 26.30 <sup>b</sup> | <sub>g</sub> 26.98 <sup>b</sup> |
| 6              | <sub>f</sub> 25.43 <sup>b</sup> | <sub>f</sub> 25.38 <sup>b</sup> | <sub>h</sub> 25.77 <sup>b</sup> | <sub>g</sub> 25.97 <sup>b</sup> |
| 9              | <sub>f</sub> 25.50 <sup>c</sup> | <sub>f</sub> 25.20 <sup>c</sup> | <sub>i</sub> 25.22 <sup>c</sup> | <sub>h</sub> 26.62 <sup>b</sup> |

N = 12.

<sup>a</sup> Percentage sweet potato flour based on amount of white potato flour.

<sup>b-e</sup> Means within a row followed by a different superscript are significantly different at P<0.05.

<sup>f-i</sup> Means in a column for Hunter L, 'a' and 'b' values preceded by a different subscript are significantly different at P<0.05.

Table 83 - Hunter L, 'a' and 'b' values of chips prepared with flour of sweet potato skin (FSPS) and white potato as affected by levels of sweet potato and storage period

| Storage, weeks | Levels of FSPS, % <sup>a</sup>  |                                  |                                  |                                  |
|----------------|---------------------------------|----------------------------------|----------------------------------|----------------------------------|
|                | 25                              | 50                               | 75                               | 100                              |
| Hunter L       |                                 |                                  |                                  |                                  |
| 0              | <sub>g</sub> 48.75 <sup>b</sup> | <sub>h</sub> 47.06 <sup>c</sup>  | <sub>h</sub> 44.40 <sup>d</sup>  | <sub>h</sub> 41.56 <sup>e</sup>  |
| 3              | <sub>g</sub> 49.50 <sup>b</sup> | <sub>gh</sub> 47.52 <sup>c</sup> | <sub>g</sub> 45.23 <sup>d</sup>  | <sub>gh</sub> 42.83 <sup>e</sup> |
| 6              | <sub>g</sub> 49.83 <sup>b</sup> | <sub>fg</sub> 49.04 <sup>b</sup> | <sub>fg</sub> 46.49 <sup>c</sup> | <sub>g</sub> 44.16 <sup>d</sup>  |
| 9              | <sub>f</sub> 51.08 <sup>b</sup> | <sub>f</sub> 49.82 <sup>b</sup>  | <sub>f</sub> 47.80 <sup>c</sup>  | <sub>f</sub> 45.74 <sup>d</sup>  |
| Hunter 'a'     |                                 |                                  |                                  |                                  |
| 0              | <sub>f</sub> 8.79 <sup>e</sup>  | <sub>f</sub> 10.39 <sup>d</sup>  | <sub>f</sub> 11.94 <sup>c</sup>  | <sub>f</sub> 13.56 <sup>b</sup>  |
| 3              | <sub>g</sub> 8.44 <sup>e</sup>  | <sub>f</sub> 10.18 <sup>d</sup>  | <sub>g</sub> 11.25 <sup>c</sup>  | <sub>g</sub> 12.86 <sup>b</sup>  |
| 6              | <sub>h</sub> 8.17 <sup>e</sup>  | <sub>g</sub> 9.57 <sup>d</sup>   | <sub>h</sub> 10.47 <sup>c</sup>  | <sub>h</sub> 11.90 <sup>b</sup>  |
| 9              | <sub>h</sub> 8.00 <sup>e</sup>  | <sub>g</sub> 9.24 <sup>d</sup>   | <sub>i</sub> 9.73 <sup>c</sup>   | <sub>h</sub> 11.62 <sup>b</sup>  |
| Hunter 'b'     |                                 |                                  |                                  |                                  |
| 0              | <sub>h</sub> 23.36 <sup>c</sup> | <sub>g</sub> 25.86 <sup>b</sup>  | <sub>g</sub> 25.58 <sup>b</sup>  | <sub>f</sub> 26.47 <sup>b</sup>  |
| 3              | <sub>h</sub> 23.93 <sup>c</sup> | <sub>g</sub> 25.96 <sup>b</sup>  | <sub>fg</sub> 26.75 <sup>b</sup> | <sub>f</sub> 27.19 <sup>b</sup>  |
| 6              | <sub>g</sub> 24.89 <sup>c</sup> | <sub>g</sub> 26.83 <sup>b</sup>  | <sub>f</sub> 27.50 <sup>b</sup>  | <sub>f</sub> 28.03 <sup>b</sup>  |
| 9              | <sub>f</sub> 25.83 <sup>c</sup> | <sub>f</sub> 28.37 <sup>b</sup>  | <sub>f</sub> 28.53 <sup>b</sup>  | <sub>f</sub> 28.38 <sup>b</sup>  |

N = 12.

<sup>a</sup> Percentage sweet potato flour based on amount of white potato flour.

<sup>b-e</sup> Means within a row followed by a different superscript are significantly different at P<0.05.

<sup>f-i</sup> Means in a column for Hunter L, 'a' and 'b' values followed by a different subscript are significantly different at P<0.05.

Table 84 - Sums of squares from the analysis of variance for Hunter L, 'a' and 'b' values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of sweet potato within each level of salt

| Source                             | df | FSPF      | FSPS     |
|------------------------------------|----|-----------|----------|
| Sums of squares                    |    |           |          |
| Hunter L                           |    |           |          |
| Levels of SP flour within salted   | 1  | 1784.67** | 463.23** |
| Error                              | 88 | 233.92    | 158.87   |
| Levels of SP flour within unsalted | 1  | 1045.52** | 646.49** |
| Error                              | 88 | 114.18    | 99.83    |
| Hunter 'a'                         |    |           |          |
| Levels of SP flour within salted   | 1  | 534.89**  | 185.71** |
| Error                              | 88 | 36.24     | 18.15    |
| Levels of SP flour within unsalted | 1  | 344.83**  | 246.62** |
| Error                              | 88 | 23.08     | 22.80    |
| Hunter 'b'                         |    |           |          |
| Levels of SP flour within salted   | 1  | 21.47**   | 203.95** |
| Error                              | 88 | 104.41    | 73.29    |
| Levels of SP flour within unsalted | 1  | 68.96**   | 77.09**  |
| Error                              | 88 | 94.16     | 246.64   |

\*\* Significant at  $P < 0.01$ .

Table 85 - Sums of squares from the analysis of variance for Hunter L, 'a' and 'b' values of chips prepared with flour sweet potato flesh (FSPF) or skin (FSPS) as affected by levels of salt within each level of sweet potato

| Source                    | df | FSPF                | FSPS                |
|---------------------------|----|---------------------|---------------------|
| Sums of squares           |    |                     |                     |
| Hunter L                  |    |                     |                     |
| Salt within 25% SP flour  | 1  | 1.88 <sup>ns</sup>  | 1.76 <sup>ns</sup>  |
| Error                     | 42 | 31.10               | 65.06               |
| Salt within 50% SP flour  | 1  | 0.20 <sup>ns</sup>  | 79.05 <sup>**</sup> |
| Error                     | 42 | 25.92               | 183.15              |
| Salt within 75% SP flour  | 1  | 16.22 <sup>**</sup> | 61.43 <sup>**</sup> |
| Error                     | 42 | 47.56               | 127.23              |
| Salt within 100% SP flour | 1  | 54.61 <sup>**</sup> | 44.47 <sup>**</sup> |
| Error                     | 42 | 139.87              | 126.47              |
| Hunter 'a'                |    |                     |                     |
| Salt within 25% SP flour  | 1  | 3.47 <sup>**</sup>  | 0.33 <sup>ns</sup>  |
| Error                     | 42 | 5.94                | 3.00                |
| Salt within 50% SP flour  | 1  | 1.24 <sup>**</sup>  | 0.05 <sup>ns</sup>  |
| Error                     | 42 | 5.88                | 9.69                |
| Salt within 75% SP flour  | 1  | 0.26 <sup>ns</sup>  | 2.48 <sup>**</sup>  |
| Error                     | 42 | 6.60                | 9.66                |
| Salt within 100% SP flour | 1  | 10.74 <sup>**</sup> | 5.60 <sup>**</sup>  |
| Error                     | 42 | 25.08               | 18.80               |
| Hunter 'b'                |    |                     |                     |
| Salt within 25% SP flour  | 1  | 23.10 <sup>**</sup> | 19.38 <sup>**</sup> |
| Error                     | 42 | 96.15               | 30.90               |

Table 85 continued

|                           |    |                      |                     |
|---------------------------|----|----------------------|---------------------|
| Salt within 50% SP flour  | 1  | 71.30 <sup>**</sup>  | 36.23 <sup>**</sup> |
| Error                     | 42 | 44.50                | 61.64               |
| Salt within 75% SP flour  | 1  | 112.24 <sup>**</sup> | 87.75 <sup>**</sup> |
| Error                     | 42 | 22.49                | 124.51              |
| Salt within 100% SP flour | 1  | 5.27 <sup>*</sup>    | 94.36 <sup>**</sup> |
| Error                     | 42 | 32.14                | 120.70              |

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\* Significant at  $P < 0.05$ .

\*\* Significant at  $P < 0.01$ .

ns Not significant at  $P < 0.05$ .



0.05). The 6 treatments remaining were equally divided between chips with FSPF and FSPS.

Hunter L, 'a' and 'b' values of chips with both SPF and white potato as affected by levels of SPF and salt are presented in Tables 86 (FSPF) and 87 (FSPS). As the levels of FSPF and FSPS increased, salted and unsalted chips became darker (reduced Hunter L) redder (increased Hunter 'a') and yellower (increased Hunter 'b'). The change in color values, however, were not significant with every increase of SPF. Overall, unsalted chips were darker and less yellow than salted chips.

Sums of squares are presented (Tables 88 and 89) from the analysis of variance for Hunter L, 'a' and 'b' values of chips with FSPF or FSPS and white potato as affected by gaseous atmospheres within each level of salt (Table 88) and levels of salt within each gaseous atmosphere (Table 89). In all but 2 cases, gaseous atmospheres affected Hunter L ( $P < 0.01$  and  $P < 0.05$ ), 'a' ( $P < 0.01$ ) and 'b' ( $P < 0.01$ ) values of salted and unsalted chips with FSPF or FSPS. With 3 exceptions levels of salt affected Hunter L, ( $P < 0.01$ ), 'a' ( $P < 0.01$  and  $0.05$ ) and 'b' ( $P < 0.01$ ) values of chips with FSPF or FSPS when held under nitrogen gas or air. Presented in Tables 90 and 91 are Hunter L, 'a' and 'b' values of chips with FSPF (Table 90) or FSPS (Table 91) and white potato as affected by levels of salt and 2 gaseous atmospheres. For chips with FSPF (Table 90), nitrogen gas atmosphere yielded

Table 86 - Hunter L, 'a' and 'b' values of chips prepared with flour of sweet potato flesh (FSPF) and white potato as affected by levels of sweet potato flour and salt

| Levels of<br>Salt | Levels of FSPF, % <sup>a</sup>  |                                 |                                 |                                  |
|-------------------|---------------------------------|---------------------------------|---------------------------------|----------------------------------|
|                   | 25                              | 50                              | 75                              | 100                              |
| Hunter L          |                                 |                                 |                                 |                                  |
| Salted            | <sub>f</sub> 58.13 <sup>b</sup> | <sub>f</sub> 56.07 <sup>c</sup> | <sub>g</sub> 51.80 <sup>d</sup> | <sub>g</sub> 46.88 <sup>e</sup>  |
| Unsalted          | <sub>f</sub> 57.73 <sup>b</sup> | <sub>f</sub> 55.94 <sup>c</sup> | <sub>f</sub> 52.97 <sup>d</sup> | <sub>f</sub> 49.02 <sup>e</sup>  |
| Hunter 'a'        |                                 |                                 |                                 |                                  |
| Salted            | <sub>g</sub> 7.51 <sup>e</sup>  | <sub>f</sub> 9.09 <sup>d</sup>  | <sub>f</sub> 10.35 <sup>c</sup> | <sub>f</sub> 13.91 <sup>b</sup>  |
| Unsalted          | <sub>f</sub> 8.05 <sup>e</sup>  | <sub>g</sub> 8.77 <sup>d</sup>  | <sub>f</sub> 10.50 <sup>c</sup> | <sub>g</sub> 12.97 <sup>b</sup>  |
| Hunter 'b'        |                                 |                                 |                                 |                                  |
| Salted            | <sub>f</sub> 26.30 <sup>d</sup> | <sub>f</sub> 26.78 <sup>c</sup> | <sub>f</sub> 27.58 <sup>b</sup> | <sub>f</sub> 27.15 <sup>bc</sup> |
| Unsalted          | <sub>g</sub> 24.91 <sup>c</sup> | <sub>g</sub> 24.34 <sup>c</sup> | <sub>g</sub> 24.53 <sup>c</sup> | <sub>g</sub> 26.49 <sup>b</sup>  |

N = 24.

<sup>a</sup> Percentage sweet potato flour based on amount of white potato flour.

<sup>b-e</sup> Means within a row followed by a different superscript are significantly different at P<0.05.

<sup>f-g</sup> Means in a column for Hunter L, 'a' and 'b' values preceded by a different subscript are significantly different at P<0.05.

Table 87 - Hunter L, 'a' and 'b' values of chips prepared with flour of sweet potato skin (FSPS) and white potato as affected by levels of sweet potato flour and levels of salt

| Levels of<br>Salt | Levels of FSPS, % <sup>a</sup>  |                                 |                                 |                                 |
|-------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
|                   | 25                              | 50                              | 75                              | 100                             |
| Hunter L          |                                 |                                 |                                 |                                 |
| Salted            | <sub>f</sub> 49.98 <sup>b</sup> | <sub>f</sub> 49.64 <sup>b</sup> | <sub>f</sub> 47.11 <sup>c</sup> | <sub>f</sub> 44.53 <sup>d</sup> |
| Unsalted          | <sub>f</sub> 49.60 <sup>b</sup> | <sub>g</sub> 47.08 <sup>c</sup> | <sub>g</sub> 44.85 <sup>d</sup> | <sub>g</sub> 42.61 <sup>e</sup> |
| Hunter 'a'        |                                 |                                 |                                 |                                 |
| Salted            | <sub>g</sub> 8.29 <sup>e</sup>  | <sub>f</sub> 9.81 <sup>d</sup>  | <sub>g</sub> 10.62 <sup>c</sup> | <sub>g</sub> 12.14 <sup>b</sup> |
| Unsalted          | <sub>f</sub> 8.46 <sup>e</sup>  | <sub>f</sub> 9.88 <sup>d</sup>  | <sub>f</sub> 11.08 <sup>c</sup> | <sub>f</sub> 12.83 <sup>b</sup> |
| Hunter 'b'        |                                 |                                 |                                 |                                 |
| Salted            | <sub>f</sub> 25.14 <sup>d</sup> | <sub>f</sub> 27.62 <sup>c</sup> | <sub>f</sub> 28.44 <sup>b</sup> | <sub>f</sub> 28.92 <sup>b</sup> |
| Unsalted          | <sub>g</sub> 23.87 <sup>c</sup> | <sub>g</sub> 25.88 <sup>b</sup> | <sub>g</sub> 25.74 <sup>b</sup> | <sub>g</sub> 26.12 <sup>b</sup> |

N = 24.

<sup>a</sup> Percentage sweet potato flour based on amount of white potato flour.

<sup>b-e</sup> Means within a row followed by a different superscript are significantly different at P<0.05.

<sup>f-g</sup> Means in a column for Hunter L, 'a' and 'b' values preceded by a different subscript are significantly different at P<0.05.

Table 88 - Sums of squares from the analysis of variance for Hunter L, 'a' and 'b' values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by gaseous atmospheres within each level of salt

| Source                              | df | FSPF                 | FSPS                 |
|-------------------------------------|----|----------------------|----------------------|
|                                     |    | Sums of squares      |                      |
|                                     |    | Hunter L             |                      |
| Gaseous atmospheres within salted   | 1  | 12.33 <sup>*</sup>   | 214.50 <sup>**</sup> |
| Error                               | 88 | 233.92               | 158.87               |
| Gaseous atmospheres within unsalted | 1  | 114.19 <sup>**</sup> | 92.04 <sup>**</sup>  |
| Error                               | 88 | 114.48               | 99.83                |
|                                     |    | Hunter 'a'           |                      |
| Gaseous atmospheres within salted   | 1  | 27.31 <sup>**</sup>  | 0.07 <sup>ns</sup>   |
| Error                               | 88 | 36.24                | 18.15                |
| Gaseous atmospheres within unsalted | 1  | 86.26 <sup>**</sup>  | 11.41 <sup>**</sup>  |
| Error                               | 88 | 23.34                | 22.80                |
|                                     |    | Hunter 'b'           |                      |
| Gaseous atmospheres within salted   | 1  | 21.09 <sup>**</sup>  | 2.31 <sup>ns</sup>   |
| Error                               | 88 | 104.41               | 73.29                |
| Gaseous atmospheres within unsalted | 1  | 24.30 <sup>**</sup>  | 250.58 <sup>**</sup> |
| Error                               | 88 | 94.16                | 246.64               |

\* Significant at  $P < 0.05$ .

\*\* Significant at  $P < 0.01$ .

ns Significant at  $P < 0.05$ .

Table 89 - Sums of squares from the analysis of variance for Hunter L, 'a' and 'b' values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of salt within each gaseous atmosphere

| Source                             | df | FSPF                 | FSPS                 |
|------------------------------------|----|----------------------|----------------------|
|                                    |    | Sums of squares      |                      |
|                                    |    | Hunter L             |                      |
| Levels of salt within nitrogen gas | 1  | 0.04 <sup>ns</sup>   | 11.41 <sup>**</sup>  |
| Error                              | 88 | 46.73                | 89.11                |
| Levels of salt within air          | 1  | 48.74 <sup>**</sup>  | 435.20 <sup>**</sup> |
| Error                              | 88 | 382.47               | 161.22               |
|                                    |    | Hunter 'a'           |                      |
| Levels of salt within nitrogen gas | 1  | 1.73 <sup>*</sup>    | 10.47 <sup>**</sup>  |
| Error                              | 88 | 34.71                | 29.76                |
| Levels of salt within air          | 1  | 7.54 <sup>**</sup>   | 0.02 <sup>ns</sup>   |
| Error                              | 88 | 77.59                | 22.38                |
|                                    |    | Hunter 'b'           |                      |
| Levels of salt within nitrogen gas | 1  | 196.08 <sup>**</sup> | 3.08 <sup>ns</sup>   |
| Error                              | 88 | 92.37                | 94.44                |
| Levels of salt within air          | 1  | 20.08 <sup>**</sup>  | 365.04 <sup>**</sup> |
| Error                              | 88 | 108.01               | 167.39               |

\* Significant at P<0.05.

\*\* Significant at P<0.01.

ns Not significant at P<0.05.

Table 90 - Hunter L, 'a' and 'b' values of chips prepared with flour of sweet potato flesh (FSPF) and white potato as affected by levels of salt and two gaseous atmospheres

| Salt       | Atmosphere                     |                                |
|------------|--------------------------------|--------------------------------|
|            | Nitrogen gas                   | Air                            |
| Hunter L   |                                |                                |
| Salted     | c <sup>52.86<sup>b</sup></sup> | d <sup>53.58<sup>a</sup></sup> |
| Unsalted   | c <sup>52.82<sup>b</sup></sup> | c <sup>55.00<sup>a</sup></sup> |
| Hunter 'a' |                                |                                |
| Salted     | d <sup>10.75<sup>a</sup></sup> | c <sup>9.68<sup>b</sup></sup>  |
| Unsalted   | c <sup>11.02<sup>a</sup></sup> | d <sup>9.12<sup>b</sup></sup>  |
| Hunter 'b' |                                |                                |
| Salted     | c <sup>27.42<sup>a</sup></sup> | c <sup>26.49<sup>b</sup></sup> |
| Unsalted   | d <sup>24.56<sup>b</sup></sup> | d <sup>25.56<sup>a</sup></sup> |

N = 48.  
a-b Means within a row followed by a different superscript are significantly different at P<0.05.  
c-d Means in a column for Hunter L, 'a' and 'b' values preceded by a different subscript are significantly different at P<0.05.

Table 91 - Hunter L, 'a' and 'b' values of chips prepared with flour of sweet potato skin (FSPS) and white potato as affected by levels of salt and two gaseous atmospheres

| Levels of<br>Salt | Atmospheres                     |                                 |
|-------------------|---------------------------------|---------------------------------|
|                   | Nitrogen gas                    | Air                             |
| Hunter L          |                                 |                                 |
| Salted            | <sub>d</sub> 46.32 <sup>b</sup> | <sub>c</sub> 49.31 <sup>a</sup> |
| Unsalted          | <sub>c</sub> 47.01 <sup>a</sup> | <sub>d</sub> 45.05 <sup>b</sup> |
| Hunter 'a'        |                                 |                                 |
| Salted            | <sub>d</sub> 10.24 <sup>a</sup> | <sub>c</sub> 10.19 <sup>a</sup> |
| Unsalted          | <sub>c</sub> 10.90 <sup>a</sup> | <sub>c</sub> 10.21 <sup>b</sup> |
| Hunter 'b'        |                                 |                                 |
| Salted            | <sub>c</sub> 27.38 <sup>a</sup> | <sub>c</sub> 27.69 <sup>a</sup> |
| Unsalted          | <sub>c</sub> 27.02 <sup>a</sup> | <sub>d</sub> 23.79 <sup>b</sup> |

N = 48.  
a-b Means within a row followed by a different superscript are significantly different at P<0.05.  
c-d Means in a column for Hunter L, 'a' and 'b' values preceded by a different subscript are significantly different at P<0.05.

chips that were darker and redder than chips held under air. Hunter 'b' values were inconclusive for yellowness; salted chips held under nitrogen gas were yellower than chips held under air and unsalted chips held under air were yellower than chips held under nitrogen gas. When held under nitrogen gas, the addition of salt had no effect on Hunter L, reduced Hunter 'a' and increased yellowness. Under the air atmosphere, salted chips had lower Hunter L and greater Hunter 'a' and 'b' values. Salted chips with FSPS (Table 91) were darker when held under nitrogen gas atmosphere while unsalted chips were lighter. Atmosphere had no effect on redness of salted chips, but unsalted chips were redder when held under nitrogen gas. Atmosphere had no effect on yellowness of salted chips, but air produced darker unsalted chips. Nitrogen gas produced redder unsalted chips, but air had no effect on Hunter 'a' values. Air produced yellower salted chips but nitrogen gas had no effect on Hunter 'b' values.

Sums of squares from the analysis of variance for Hunter L, 'a' and 'b' values of chips with both SPF and white potato as affected by gaseous atmospheres within each storage period are presented in Table 92. Similar information is presented in Table 93 for storage periods within each gaseous atmosphere. During most storage periods (Table 92), gaseous atmospheres affected Hunter L ( $P < 0.01$  and  $P < 0.05$ ) and 'a' ( $P < 0.01$ ) values of chips with FSPF, but



Table 92 - Sums of squares from the analysis of variance for Hunter L, 'a' and 'b' values of chips prepared with flour sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by two gaseous atmospheres within each storage period

| Source                             | df | FSPF    | FSPS               |
|------------------------------------|----|---------|--------------------|
| Sums of squares                    |    |         |                    |
| Hunter L                           |    |         |                    |
| Gaseous atmospheres within 0 week  | 1  | 3.36**  | 12.00*             |
| Error                              | 42 | 16.73   | 76.51              |
| Gaseous atmospheres within 3 weeks | 1  | 18.88** | 0.13 <sup>ns</sup> |
| Error                              | 42 | 29.28   | 114.62             |
| Gaseous atmospheres within 6 weeks | 1  | 42.56** | 20.94*             |
| Error                              | 42 | 87.14   | 171.19             |
| Gaseous atmospheres within 9 weeks | 1  | 54.40** | 32.18**            |
| Error                              | 42 | 248.50  | 154.71             |
| Hunter 'a'                         |    |         |                    |
| Gaseous atmospheres within 0 week  | 1  | 20.15** | 0.37 <sup>ns</sup> |
| Error                              | 42 | 12.70   | 5.79               |
| Gaseous atmospheres within 3 weeks | 1  | 19.13** | 3.31**             |
| Error                              | 42 | 18.82   | 14.88              |
| Gaseous atmospheres within 6 weeks | 1  | 28.37** | 2.08**             |
| Error                              | 42 | 17.66   | 8.91               |

Table 92 continued

|                                       |    |                     |                     |
|---------------------------------------|----|---------------------|---------------------|
| Gaseous atmospheres within<br>9 weeks | 1  | 40.15 <sup>**</sup> | 1.65 <sup>**</sup>  |
| Error                                 | 42 | 23.16               | 8.74                |
| Hunter 'b'                            |    |                     |                     |
| Gaseous atmospheres within<br>0 week  | 1  | 28.37 <sup>**</sup> | 60.98 <sup>**</sup> |
| Error                                 | 42 | 25.25               | 110.04              |
| Gaseous atmospheres within<br>3 weeks | 1  | 0.65 <sup>ns</sup>  | 13.65 <sup>*</sup>  |
| Error                                 | 42 | 66.06               | 96.46               |
| Gaseous atmospheres within<br>6 weeks | 1  | 4.81 <sup>ns</sup>  | 23.52 <sup>**</sup> |
| Error                                 | 42 | 82.44               | 111.89              |
| Gaseous atmospheres within<br>9 weeks | 1  | 12.00 <sup>**</sup> | 15.08 <sup>*</sup>  |
| Error                                 | 42 | 52.11               | 152.06              |

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\* Significant at  $P < 0.05$ .

\*\* Significant at  $P < 0.01$ .

ns Not significant at  $P < 0.05$ .

Table 93 - Sums of squares from the analysis of variance for Hunter L, 'a' and 'b' values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) as affected by storage periods within each gaseous atmosphere

| Source                      | df | FSPF               | FSPS     |
|-----------------------------|----|--------------------|----------|
| Sums of squares             |    |                    |          |
| Hunter L                    |    |                    |          |
| Storage within nitrogen gas | 3  | 19.24**            | 47.92**  |
| Error                       | 88 | 46.73              | 89.01    |
| Storage within air          | 3  | 106.36**           | 277.19** |
| Error                       | 88 | 382.46             | 161.22   |
| Hunter 'a'                  |    |                    |          |
| Storage within nitrogen gas | 3  | 6.68**             | 30.97**  |
| Error                       | 88 | 34.71              | 29.76    |
| Storage within air          | 3  | 18.97**            | 36.76**  |
| Error                       | 88 | 77.58              | 22.38    |
| Hunter 'b'                  |    |                    |          |
| Storage within nitrogen gas | 3  | 1.64 <sup>ns</sup> | 59.24**  |
| Error                       | 88 | 92.37              | 94.41    |
| Storage within air          | 3  | 74.63**            | 115.89** |
| Error                       | 88 | 108.01             | 167.39   |

\*\* Significant at  $P < 0.01$ .

<sup>ns</sup> Not significant at  $P < 0.05$ .

Hunter 'b' was affected only at 0 and 9 weeks. Gaseous atmosphere affected color of chips with FSPS; Hunter L ( $P < 0.01$  or  $P < 0.05$ ), except 3-week storage; Hunter 'a' ( $P < 0.01$ ), except 0-week, and Hunter 'b' ( $P < 0.01$  or  $P < 0.05$ ). Storage periods affected ( $P < 0.01$ ) Hunter L, 'a' and 'b' values of chips with all SPF held under both atmospheres except under nitrogen gas (Hunter 'b', FSPF). The 3 Hunter values were affected by storage period when chips with either SPF were held under nitrogen gas or air, except Hunter 'b' under nitrogen gas (Table 93).

Presented in Tables 94 and 95 are Hunter L, 'a' and 'b' values of chips with FSPF (Table 94) or FSPS (Table 95) as affected by storage periods and 2 gaseous atmospheres. Chips with FSPF held under nitrogen gas were darker and redder than chips held under air (Table 94). Atmosphere had no effect on Hunter 'b' values during storage, except at 0-week chips had lower Hunter 'b' values under nitrogen gas. During storage, chips became lighter and less red under both atmospheres. Storage had no effect on yellowness of chips held under nitrogen gas but decreased yellowness under air. Where significant, chips with FSPS held under nitrogen were darker (except 0-week), redder and yellower (Table 95). As chips were held under either atmosphere, Hunter L increased, Hunter 'a' decreased and Hunter 'b' increased. Thus, the chips became lighter, less red and yellower.

Table 94 - Hunter L, 'a' and 'b' values of chips prepared with flour of sweet potato flesh (FSPF) and white potato flour as affected by storage periods and two gaseous atmospheres

| Storage, weeks | Atmospheres         |                     |
|----------------|---------------------|---------------------|
|                | Nitrogen gas        | Air                 |
| Hunter L       |                     |                     |
| 0              | e52.23 <sup>b</sup> | f52.76 <sup>a</sup> |
| 3              | d52.74 <sup>b</sup> | e54.00 <sup>a</sup> |
| 6              | d52.91 <sup>b</sup> | d54.79 <sup>a</sup> |
| 9              | c53.49 <sup>b</sup> | c55.62 <sup>a</sup> |
| Hunter 'a'     |                     |                     |
| 0              | c11.33 <sup>a</sup> | c10.03 <sup>b</sup> |
| 3              | d10.82 <sup>a</sup> | d 9.56 <sup>b</sup> |
| 6              | d10.71 <sup>a</sup> | e 9.17 <sup>b</sup> |
| 9              | d10.67 <sup>a</sup> | f 8.84 <sup>b</sup> |
| Hunter 'b'     |                     |                     |
| 0              | c25.80 <sup>b</sup> | c27.34 <sup>a</sup> |
| 3              | c26.09 <sup>a</sup> | d26.33 <sup>a</sup> |
| 6              | c25.95 <sup>a</sup> | e25.32 <sup>a</sup> |
| 9              | c26.13 <sup>a</sup> | e25.13 <sup>b</sup> |

N = 24.  
a-b Means within a row followed by a different superscript are significantly different at P<0.05.  
c-f Means in a column for Hunter L, 'a' and 'b' values preceded by a different subscript are significantly different at P<0.05.

Table 95 - Hunter L, 'a' and 'b' values of chips prepared with flour of sweet potato skin (FSPS) and white potato as affected by storage periods and two gaseous atmospheres

| Storage, weeks | Atmospheres                    |                                |
|----------------|--------------------------------|--------------------------------|
|                | Nitrogen gas                   | Air                            |
| Hunter L       |                                |                                |
| 0              | e <sup>45.94<sup>a</sup></sup> | f <sup>44.94<sup>b</sup></sup> |
| 3              | e <sup>46.22<sup>a</sup></sup> | e <sup>46.32<sup>a</sup></sup> |
| 6              | d <sup>46.72<sup>b</sup></sup> | d <sup>48.04<sup>a</sup></sup> |
| 9              | c <sup>47.79<sup>b</sup></sup> | c <sup>49.43<sup>a</sup></sup> |
| Hunter 'a'     |                                |                                |
| 0              | c <sup>11.26<sup>a</sup></sup> | c <sup>11.08<sup>a</sup></sup> |
| 3              | d <sup>10.97<sup>a</sup></sup> | d <sup>10.45<sup>b</sup></sup> |
| 6              | e <sup>10.23<sup>a</sup></sup> | e <sup>9.82<sup>b</sup></sup>  |
| 9              | f <sup>9.83<sup>a</sup></sup>  | f <sup>9.46<sup>b</sup></sup>  |
| Hunter 'b'     |                                |                                |
| 0              | e <sup>26.44<sup>a</sup></sup> | f <sup>24.19<sup>b</sup></sup> |
| 3              | e <sup>26.49<sup>a</sup></sup> | e <sup>25.43<sup>b</sup></sup> |
| 6              | d <sup>27.51<sup>a</sup></sup> | d <sup>26.11<sup>b</sup></sup> |
| 9              | c <sup>28.34<sup>a</sup></sup> | c <sup>27.22<sup>b</sup></sup> |

N = 24.  
a-b Means within a row followed by a different superscript are significantly different at P<0.05.  
c-f Means in a column for Hunter L, 'a' and 'b' values preceded by a different subscript are significantly different at P<0.05.

Sums of squares from the analysis of variance for Hunter color values of chips with FSPF or FSPS and white potato as affected by levels of salt within each storage period are presented in Table 96. Similar information for storage periods within levels of salt is presented in Table 97. Levels of salt affected Hunter L, 'a' ( $P<0.01$  and  $P<0.05$ ) and 'b' ( $P<0.01$ ) values of chips with both SPF at a majority of the storage periods (Table 96). Hunter 'a' was affected least, while Hunter 'b' was affected most. The 3 Hunter color values were affected ( $P<0.01$ ) during storage regardless of the presence or absence of salt (Table 97).

Presented in Tables 98 and 99 are Hunter L, 'a' and 'b' values of chips with FSPF (Table 98) or FSPS (Table 99) as affected by storage periods and levels of salt. Where applicable, salted chips with FSPF were lighter, redder, yellower within periods of storage than unsalted chips (Table 98). Generally chips of salted and unsalted treatments became lighter, less red and less yellow during storage. Salted chips with FSPS were darker and more yellow than unsalted chips (Table 99). Hunter 'a' values indicated less effect of redness due to salt. Similar to chips with FSPF, chips with FSPS became lighter and less red during storage. However, the chips became yellower with extended storage.

Table 96 - Sums of squares from the analysis of variance for Hunter L, 'a' and 'b' values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) and white potato as affected by levels of salt within each storage period

| Source                           | df | FSPF                | FSPS                |
|----------------------------------|----|---------------------|---------------------|
| Sums of square                   |    |                     |                     |
| Hunter L                         |    |                     |                     |
| Levels of salt within<br>0 week  | 1  | 3.26 <sup>**</sup>  | 12.40 <sup>*</sup>  |
| Error                            | 42 | 16.73               | 76.51               |
| Levels of salt within<br>3 weeks | 1  | 6.83 <sup>**</sup>  | 13.76 <sup>*</sup>  |
| Error                            | 42 | 29.28               | 114.62              |
| Levels of salt within<br>6 weeks | 1  | 3.85 <sup>ns</sup>  | 67.45 <sup>**</sup> |
| Error                            | 42 | 87.40               | 171.19              |
| Levels of salt within<br>9 weeks | 1  | 10.36 <sup>ns</sup> | 86.14               |
| Error                            | 42 | 248.50              | 154.71              |
| Hunter 'a'                       |    |                     |                     |
| Levels of salt within<br>0 week  | 1  | 0.42 <sup>ns</sup>  | 1.20 <sup>**</sup>  |
| Error                            | 42 | 12.70               | 5.79                |
| Levels of salt within<br>3 weeks | 1  | 0.08 <sup>ns</sup>  | 1.08 <sup>ns</sup>  |
| Error                            | 42 | 18.82               | 14.88               |
| Levels of salt within<br>6 weeks | 1  | 0.01 <sup>ns</sup>  | 3.20 <sup>**</sup>  |
| Error                            | 42 | 17.66               | 8.91                |
| Levels of salt within<br>9 weeks | 1  | 2.48 <sup>*</sup>   | 9.10 <sup>**</sup>  |
| Error                            | 42 | 23.16               | 8.74                |



Table 96 continued

|                       |    | Hunter 'b' |         |
|-----------------------|----|------------|---------|
| Levels of salt within | 1  | 33.17**    | 40.15** |
| 0 week                |    |            |         |
| Error                 | 42 | 25.25      | 110.04  |
| Levels of salt within | 1  | 58.96**    | 60.30** |
| 3 weeks               |    |            |         |
| Error                 | 42 | 66.06      | 96.46   |
| Levels of salt within | 1  | 38.00**    | 56.77** |
| 6 weeks               |    |            |         |
| Error                 | 42 | 82.44      | 111.89  |
| Levels of salt within | 1  | 42.94**    | 61.88** |
| 9 weeks               |    |            |         |
| Error                 | 42 | 52.11      | 152.06  |

\* Significant at  $P < 0.05$ .

\*\* Significant at  $P < 0.01$ .

ns Not significant at  $P < 0.05$ .

Table 97 - Sums of squares from the analysis of variance for Hunter L, 'a' and 'b' values of chips prepared with flour of sweet potato flesh (FSPF) or skin (FSPS) as affected by storage periods within each level of salt

| Source                  | df | FSPF    | FSPS     |
|-------------------------|----|---------|----------|
| Sums of squares         |    |         |          |
| Hunter L                |    |         |          |
| Storage within salted   | 3  | 45.36** | 230.96** |
| Error                   | 88 | 233.92  | 158.87   |
| Storage within unsalted | 3  | 63.07** | 68.59**  |
| Error                   | 88 | 114.18  | 99.83    |
| Hunter 'a'              |    |         |          |
| Storage within salted   | 3  | 10.60** | 61.57**  |
| Error                   | 88 | 36.24   | 18.15    |
| Storage within unsalted | 3  | 14.53** | 14.34**  |
| Error                   | 88 | 23.08   | 22.80    |
| Hunter 'b'              |    |         |          |
| Storage within salted   | 3  | 15.81** | 94.65**  |
| Error                   | 88 | 104.41  | 73.29    |
| Storage within unsalted | 3  | 16.75** | 71.13**  |
| Error                   | 88 | 94.16   | 246.64   |

\*\* Significant at  $P < 0.05$ .

Table 98 - Hunter L 'a' and 'b' values of chips prepared with flour of sweet potato flesh (FSPF) and white potato flour as affected by storage periods and levels of salt

| Storage, weeks | Salt                |                      |
|----------------|---------------------|----------------------|
|                | Salted              | Unsalted             |
| Hunter L       |                     |                      |
| 0              | e52.76 <sup>a</sup> | e52.24 <sup>b</sup>  |
| 3              | d53.75 <sup>a</sup> | de52.99 <sup>b</sup> |
| 6              | d54.13 <sup>a</sup> | cd53.57 <sup>a</sup> |
| 9              | c55.20 <sup>a</sup> | c54.09 <sup>a</sup>  |
| Hunter 'a'     |                     |                      |
| 0              | c10.78 <sup>a</sup> | c10.59 <sup>b</sup>  |
| 3              | d10.15 <sup>a</sup> | d10.23 <sup>a</sup>  |
| 6              | d 9.95 <sup>a</sup> | e 9.93 <sup>a</sup>  |
| 9              | d 9.98 <sup>a</sup> | f 9.53 <sup>b</sup>  |
| Hunter 'b'     |                     |                      |
| 0              | c27.40 <sup>a</sup> | c25.74 <sup>b</sup>  |
| 3              | c27.32 <sup>a</sup> | d25.10 <sup>b</sup>  |
| 6              | d26.52 <sup>a</sup> | d24.75 <sup>b</sup>  |
| 9              | d26.58 <sup>a</sup> | d24.69 <sup>b</sup>  |

- N = 24.
- a-b Means within a row followed by a different superscript are significantly different at P<0.05.
- c-f Means in a column for Hunter L, 'a' and 'b' values preceded by a different subscript are significantly different at P<0.05.

Table 99 - Hunter L, 'a' and 'b' values of chips prepared with flour of sweet potato skin (FSPS) and white potato as affected by storage periods and levels of salt

| Storage, weeks | Salt                           |                                 |
|----------------|--------------------------------|---------------------------------|
|                | Salted                         | Unsalted                        |
| Hunter L       |                                |                                 |
| 0              | f <sup>45.95<sup>a</sup></sup> | e <sup>44.93<sup>b</sup></sup>  |
| 3              | e <sup>46.80<sup>a</sup></sup> | d <sup>45.73<sup>b</sup></sup>  |
| 6              | d <sup>48.57<sup>a</sup></sup> | d <sup>46.20<sup>b</sup></sup>  |
| 9              | c <sup>49.95<sup>a</sup></sup> | c <sup>47.27<sup>b</sup></sup>  |
| Hunter 'a'     |                                |                                 |
| 0              | c <sup>11.33<sup>a</sup></sup> | c <sup>11.01<sup>b</sup></sup>  |
| 3              | d <sup>10.56<sup>a</sup></sup> | c <sup>10.86<sup>a</sup></sup>  |
| 6              | e <sup>9.77<sup>b</sup></sup>  | d <sup>10.28<sup>a</sup></sup>  |
| 9              | f <sup>9.21<sup>b</sup></sup>  | d <sup>10.08<sup>a</sup></sup>  |
| Hunter 'b'     |                                |                                 |
| 0              | f <sup>26.23<sup>a</sup></sup> | e <sup>24.40<sup>b</sup></sup>  |
| 3              | e <sup>27.08<sup>a</sup></sup> | de <sup>24.84<sup>b</sup></sup> |
| 6              | d <sup>27.90<sup>a</sup></sup> | cd <sup>25.73<sup>b</sup></sup> |
| 9              | c <sup>28.91<sup>a</sup></sup> | c <sup>26.64<sup>b</sup></sup>  |

N = 24.  
a-b Means within a row followed by a different superscript are significantly different at P<0.05.  
c-f Means in a column for Hunter L, 'a' and 'b' values preceded by a different subscript are significantly different at P<0.05.

### C. Sensory Analysis

F-ratios from the analysis of variance for sensory scores of color, texture and overall acceptability of chips prepared with FSPF and white potato are presented in Table 100. Levels of FSPF affected ( $P<0.01$ ) color, texture and overall acceptability scores; level of salt affected ( $P<0.05$ ) texture only and gaseous atmospheres affected ( $P<0.01$ ) color and overall acceptability. The interaction levels of FSPF x salt affected ( $P<0.01$ ) texture and overall acceptability, and levels of salt x gaseous atmospheres affected ( $P<0.05$ ) color, texture and overall acceptability.

Sensory mean scores are presented in Table 101 for chips with FSPF as affected by levels of SPF, levels of salt and 2 gaseous atmospheres. Scores of the 3 attributes were inversely related to level of FSPF; as the level increased, the scores decreased. At 25% FSPF, color of chips was "liked moderately" and decreased to "liked slightly" at 100% FSPF. At 25% FSPF, texture and overall acceptability were close to "liked moderately", and at 100% FSPS, "liked slightly." Level of salt did not affect color and overall acceptability score, but unsalted chips received the lower score for texture. All 3 attributes received the higher score when chips were held under nitrogen gas.

Table 102 presents mean scores for texture and overall acceptability of chips as affected by levels of FSPF within

Table 100 - F-ratios from the analysis of variance for sensory scores of color, texture and overall acceptability of chips prepared with flour of sweet potato flesh (FSPF) and white potato

| Source             | df | Color               | Texture            | Overall             |
|--------------------|----|---------------------|--------------------|---------------------|
|                    |    |                     |                    | Acceptability       |
| F-ratios           |    |                     |                    |                     |
| Levels of FSPF (L) | 3  | 19.92 <sup>**</sup> | 9.53 <sup>**</sup> | 13.39 <sup>**</sup> |
| Salt (S)           | 1  | 2.17 <sup>ns</sup>  | 4.52 <sup>*</sup>  | 3.25 <sup>ns</sup>  |
| Gas (G)            | 1  | 6.77 <sup>**</sup>  | 3.77 <sup>ns</sup> | 9.91 <sup>**</sup>  |
| L x S              | 3  | 1.29 <sup>ns</sup>  | 4.62 <sup>**</sup> | 5.11 <sup>**</sup>  |
| L x G              | 3  | 0.48 <sup>ns</sup>  | 0.13 <sup>ns</sup> | 0.20 <sup>ns</sup>  |
| S x G              | 1  | 5.33 <sup>*</sup>   | 3.97 <sup>*</sup>  | 4.93 <sup>*</sup>   |
| L x S x G          | 3  | 0.61 <sup>ns</sup>  | 1.67 <sup>ns</sup> | 0.88 <sup>ns</sup>  |
| Mean Squares       |    |                     |                    |                     |
| Residual Error     | 3  | 1.53                | 1.77               | 1.55                |

\* Significant at P<0.05.

\*\* Significant at P<0.01.

ns Not significant at P<0.05.

Table 101 - Sensory mean scores of chips prepared with flour of sweet potato flesh (FSPF) and white potato as affected by levels of sweet potato flour, levels of salt and gaseous atmosphere after nine weeks storage<sup>a</sup>

| Levels of             |                    | Levels of |                   | Gaseous      |                   |
|-----------------------|--------------------|-----------|-------------------|--------------|-------------------|
| SPF                   |                    | Salt      |                   | Atmospheres  |                   |
| Color                 |                    |           |                   |              |                   |
| 25                    | 6.30 <sup>b</sup>  | Salted    | 5.88 <sup>b</sup> | Nitrogen gas | 5.95 <sup>b</sup> |
| 50                    | 6.17 <sup>b</sup>  | Unsalted  | 5.69 <sup>b</sup> | Air          | 5.62 <sup>c</sup> |
| 75                    | 5.55 <sup>c</sup>  |           |                   |              |                   |
| 100                   | 5.11 <sup>d</sup>  |           |                   |              |                   |
| Texture               |                    |           |                   |              |                   |
| 25                    | 5.95 <sup>b</sup>  | Salted    | 5.90 <sup>b</sup> | Nitrogen gas | 5.69 <sup>b</sup> |
| 50                    | 5.80 <sup>bc</sup> | Unsalted  | 5.41 <sup>c</sup> | Air          | 5.42 <sup>b</sup> |
| 75                    | 5.46 <sup>c</sup>  |           |                   |              |                   |
| 100                   | 5.00 <sup>d</sup>  |           |                   |              |                   |
| Overall Acceptability |                    |           |                   |              |                   |
| 25                    | 5.83 <sup>b</sup>  | Salted    | 5.60 <sup>b</sup> | Nitrogen gas | 5.68 <sup>b</sup> |
| 50                    | 5.90 <sup>b</sup>  | Unsalted  | 5.37 <sup>b</sup> | Air          | 5.28 <sup>c</sup> |
| 75                    | 5.26 <sup>c</sup>  |           |                   |              |                   |
| 100                   | 4.94 <sup>d</sup>  |           |                   |              |                   |

N = 25.

<sup>a</sup> Scoring system: 1 = dislike extremely; 4 = dislike slightly; 5 = like slightly; 6 = like moderately; 8 = like extremely.

<sup>b-d</sup> Means within a column followed by a different superscript are significantly different at  $P < 0.05$ .

Table 102 - Texture and overall acceptability sensory scores of chips prepared with flour of sweet potato flesh (FSPF) and white potato as affected by levels of sweet potato flour and salt after nine weeks of storage<sup>a</sup>

| Levels of<br>Salt | Levels of FSPF, % <sup>b</sup> |                    |                    |                     |
|-------------------|--------------------------------|--------------------|--------------------|---------------------|
|                   | 25                             | 50                 | 75                 | 100                 |
|                   | Texture                        |                    |                    |                     |
| Salted            | e6.25 <sup>c</sup>             | e6.01 <sup>c</sup> | e5.82 <sup>c</sup> | f4.72 <sup>d</sup>  |
| Unsalted          | f5.64 <sup>c</sup>             | e5.59 <sup>c</sup> | f5.10 <sup>d</sup> | e5.28 <sup>cd</sup> |
|                   | Overall acceptability          |                    |                    |                     |
| Salted            | e6.07 <sup>c</sup>             | e6.10 <sup>c</sup> | e5.59 <sup>c</sup> | f4.63 <sup>d</sup>  |
| Unsalted          | f5.60 <sup>c</sup>             | f5.70 <sup>c</sup> | f4.93 <sup>d</sup> | e5.25 <sup>cd</sup> |

N = 25.

<sup>a</sup> Scoring system is presented in footnote, Table 101.

<sup>b</sup> Percentage sweet potato flour based on amount of white potato flour.

<sup>c-d</sup> Means within a row followed by a different superscript are significantly different at P<0.05.

<sup>e-f</sup> Means within a column preceded by a different subscript are significantly different at P<0.05.



each salt level and level of salt within each level of FSPF. Overall, texture and overall acceptability scores decreased for salted and unsalted chips as level of FSPF increased. Thus, the most "liked" chips had 25% or 50% FSPF. Salted chips received the higher texture score at 25 and 75% FSPF, the lower score at 100% FSPF and no difference in score at 50% FSPF. Overall acceptability scores were greater for chips at 25, 50 and 75% FSPF. At 100% FSPF, unsalted chips received the higher score.

Table 103 presents mean scores for color, texture and overall acceptability as affected by gaseous atmosphere for salted or unsalted chips and by level of salt within each atmosphere. Scores for the 3 attributes were greater for salted chips when held under nitrogen gas. The gaseous atmosphere had no effect for unsalted chips. For chips held under nitrogen gas, the salted chips received the greater score. Scores for chips held under air were not difference between salted and unsalted chips. Obviously, the most acceptable chips were salted and stored under nitrogen gas.

F-ratios from the analysis of variance for sensory scores of color texture and overall acceptability of chips prepared with FSPS and white potato are presented in Table 104. Levels of FSPS affected ( $P < 0.01$ ) scores for color and overall acceptability, all levels of salt and gaseous atmospheres affected ( $P < 0.05$ ) scores for the 3 attributes. The interaction level of FSPS x level salt of affected

Table 103 - Color, texture and overall acceptability sensory scores of chips prepared with flour of sweet potato flesh (FSPF) and white potato as affected by levels of salt and two gaseous atmospheres after nine weeks storage<sup>a</sup>

| Levels of Salt        | Atmospheres                   |                               |
|-----------------------|-------------------------------|-------------------------------|
|                       | Nitrogen gas                  | Air                           |
| Color                 |                               |                               |
| Salted                | d <sup>6.18<sup>b</sup></sup> | d <sup>5.57<sup>c</sup></sup> |
| Unsalted              | e <sup>5.71<sup>b</sup></sup> | d <sup>5.67<sup>b</sup></sup> |
| Texture               |                               |                               |
| Salted                | d <sup>5.97<sup>b</sup></sup> | d <sup>5.43<sup>c</sup></sup> |
| Unsalted              | e <sup>5.40<sup>b</sup></sup> | d <sup>5.41<sup>b</sup></sup> |
| Overall acceptability |                               |                               |
| Salted                | d <sup>5.94<sup>b</sup></sup> | d <sup>5.26<sup>c</sup></sup> |
| Unsalted              | e <sup>5.43<sup>b</sup></sup> | d <sup>5.31<sup>b</sup></sup> |

- N = 25.
- <sup>a</sup> Scoring system is presented in footnote, Table 101.
- <sup>b-c</sup> Means within a row followed by a different superscript are significantly different at P<0.05.
- <sup>d-e</sup> Means within a column preceded by a different subscript are significantly different at P<0.05.

Table 104 - F-ratios from the analysis of variance for sensory score of color, texture and overall acceptability of chips prepared with flour of sweet potato skin (FSPS) and white potato

|                    |    |                    |                    | Overall            |
|--------------------|----|--------------------|--------------------|--------------------|
| Source             | df | Color              | Texture            | Acceptability      |
| F-ratios           |    |                    |                    |                    |
| Levels of FSPS (L) | 3  | 62.60**            | 1.55 <sup>ns</sup> | 10.54**            |
| Salt (S)           | 1  | 15.25**            | 24.85**            | 24.72**            |
| Gas (G)            | 1  | 21.54**            | 13.99**            | 15.95**            |
| L x S              | 3  | 0.52 <sup>ns</sup> | 2.47 <sup>ns</sup> | 3.11*              |
| L x G              | 3  | 4.38**             | 4.93**             | 5.02**             |
| S x G              | 1  | 1.08 <sup>ns</sup> | 0.02 <sup>ns</sup> | 0.15 <sup>ns</sup> |
| L x S x G          | 3  | 2.91*              | 1.83 <sup>ns</sup> | 2.55 <sup>ns</sup> |
| Mean Squares       |    |                    |                    |                    |
| Residual Error     | 3  | 1.31               | 1.91               | 1.72               |

\* Significant at  $P < 0.05$ .

\*\* Significant at  $P < 0.01$ .

<sup>ns</sup> Not significant at  $P < 0.05$ .

( $P < 0.05$ ) overall acceptability, while level of FSPS x gaseous atmosphere affected ( $P < 0.05$ ) scores of the 3 quality attributes.

Table 105 presents mean scores for the main factors of Table 104. Color and overall acceptability scores decreased as level of FSPS increased, but scores for texture were unchanged. The most preferred chips contained 25% FSPS. Salted chips received the greater score for each attribute, and chips held under nitrogen gas received the greater score for each attribute.

Scores for overall acceptability of chips with FSPS as affected by level of FSPS for salted or unsalted chips and as affected by level of salt at each level of FSPS are presented in Table 106.

Table 107 presents scores for color, texture and overall acceptability of chips as affected by level of FSPS when held under nitrogen gas or air and as affected by atmosphere within each level of FSPS. Color scores decreased as level of FSPS increased, indicating that panelists "liked" chips with 25% FSPS. Level of FSPS had no effect on texture scores for chips held under nitrogen gas. Overall acceptability scores generally decreased as level of FSPS increased. Atmosphere affected the color, texture and overall acceptability scores of chips with 25 and 50% FSPS; chips held under nitrogen gas had the greater scores. At 75

and 100% levels of FSPS, atmosphere had no effect on the scores.

Mean Tables for the 4-way interactions are presented in the Appendix section of this study.

Table 105 - Sensory mean scores of chips prepared with flour of sweet potato skin (FSPS) and white potato as affected by levels of sweet potato flour, levels of salt and gaseous atmosphere after nine weeks storage<sup>a</sup>

| Levels of<br>SPF      |                   | Levels of<br>Salt |                   | Gaseous<br>Atmospheres |                   |
|-----------------------|-------------------|-------------------|-------------------|------------------------|-------------------|
| Color                 |                   |                   |                   |                        |                   |
| 25                    | 5.29 <sup>b</sup> | Salted            | 4.42 <sup>b</sup> | Nitrogen gas           | 4.47 <sup>b</sup> |
| 50                    | 4.67 <sup>c</sup> | Unsalted          | 3.95 <sup>c</sup> | Air                    | 3.90 <sup>c</sup> |
| 75                    | 3.51 <sup>d</sup> |                   |                   |                        |                   |
| 100                   | 3.27 <sup>e</sup> |                   |                   |                        |                   |
| Texture               |                   |                   |                   |                        |                   |
| 25                    | 4.97 <sup>b</sup> | Salted            | 5.26 <sup>b</sup> | Nitrogen gas           | 5.17 <sup>b</sup> |
| 50                    | 5.12 <sup>b</sup> | Unsalted          | 4.55 <sup>c</sup> | Air                    | 4.63 <sup>c</sup> |
| 75                    | 4.72 <sup>b</sup> |                   |                   |                        |                   |
| 100                   | 4.99 <sup>b</sup> |                   |                   |                        |                   |
| Overall Acceptability |                   |                   |                   |                        |                   |
| 25                    | 4.88 <sup>b</sup> | Salted            | 4.76 <sup>b</sup> | Nitrogen gas           | 4.69 <sup>b</sup> |
| 50                    | 4.71 <sup>b</sup> | Unsalted          | 4.10 <sup>c</sup> | Air                    | 4.17 <sup>c</sup> |
| 75                    | 4.02 <sup>c</sup> |                   |                   |                        |                   |
| 100                   | 4.11 <sup>c</sup> |                   |                   |                        |                   |

N = 25.

<sup>a</sup> Scoring system is presented in footnote, Table 101.

<sup>b-e</sup> Means within a column followed by a different superscript are significantly different at  $P < 0.05$ .

Table 106 - Overall acceptability sensory scores of chips prepared with flour of sweet potato skin (FSPS) and white potato as affected by levels of sweet potato flour and salt after nine weeks of storage<sup>a</sup>

| Levels of Salt | Levels of FSPS, % <sup>b</sup> |                               |                               |                               |
|----------------|--------------------------------|-------------------------------|-------------------------------|-------------------------------|
|                | 25                             | 50                            | 75                            | 100                           |
| Salted         | e <sup>5.51<sup>c</sup></sup>  | e <sup>5.00<sup>c</sup></sup> | e <sup>4.10<sup>d</sup></sup> | e <sup>4.42<sup>d</sup></sup> |
| Unsalted       | f <sup>4.24<sup>c</sup></sup>  | f <sup>4.42<sup>c</sup></sup> | e <sup>3.95<sup>c</sup></sup> | f <sup>3.81<sup>c</sup></sup> |

N = 25.

<sup>a</sup> Scoring system is presented in footnote, Table 101.

<sup>b</sup> Percent sweet potato flour based on amount of white potato flour.

<sup>c-d</sup> Means within a row followed by a different superscript are significantly different at  $P < 0.05$ .

<sup>e-f</sup> Means within a column preceded by a different subscript are significantly different at  $P < 0.05$ .

Table 107 - Color, texture and overall acceptability sensory scores of chips prepared with flour of sweet potato skin (FSPS) and white potato as affected by levels of sweet potato and two gaseous atmospheres<sup>a</sup>

| Gaseous<br>Atmospheres | Levels of FSPS, % <sup>b</sup> |                    |                    |                     |
|------------------------|--------------------------------|--------------------|--------------------|---------------------|
|                        | 25                             | 50                 | 75                 | 100                 |
| Color                  |                                |                    |                    |                     |
| Nitrogen gas           | f5.73 <sup>c</sup>             | f5.23 <sup>d</sup> | f3.55 <sup>e</sup> | f3.38 <sup>e</sup>  |
| Air                    | g4.85 <sup>c</sup>             | g4.12 <sup>d</sup> | f3.42 <sup>e</sup> | f3.17 <sup>e</sup>  |
| Texture                |                                |                    |                    |                     |
| Nitrogen gas           | f5.24 <sup>d</sup>             | f5.84 <sup>c</sup> | f4.79 <sup>d</sup> | f4.82 <sup>d</sup>  |
| Air                    | f4.71 <sup>c</sup>             | g4.40 <sup>c</sup> | f4.66 <sup>c</sup> | f4.76 <sup>c</sup>  |
| Overall acceptability  |                                |                    |                    |                     |
| Nitrogen gas           | f5.25 <sup>c</sup>             | f5.34 <sup>c</sup> | f4.07 <sup>d</sup> | f4.11 <sup>d</sup>  |
| Air                    | g4.51 <sup>c</sup>             | g4.09 <sup>d</sup> | f3.97 <sup>d</sup> | f4.12 <sup>cd</sup> |

N = 25.

<sup>a</sup> Scoring system is presented in footnote, Table 101.

<sup>b</sup> Percentage sweet potato flour based on amount of white potato flour.

<sup>c-e</sup> Means within a row followed by a different superscript are significantly different at P<0.05.

<sup>f-g</sup> Means within a column preceded by a different subscript are significantly different at P<0.05.



## CHAPTER V

### SUMMARY AND CONCLUSIONS

The objectives of this research were to develop chips from flour of sweet potato (SP) flesh (FSPF) or skin (FSPS) of sweet potato and white potato (WP) and to measure chemical, physical and sensory attributes of the chips.

SP (Ipomoea batatas, Lam) roots of orange flesh, red skin and a moist-type unknown cultivar were purchased from a wholesaler and washed, cut into 1.2 cm slices, immersed into 0.25% citric acid solution and heated in an atmospheric pressure blancher/cooker for 10 min. Flesh and skin were pureed separately, dried on a double drum-dryer and ground into flour. Individual SP flours and white potato flour were mixed together such that the mixture contained SP flour at 25, 50, 75 and 100% of the amount of white potato flour present. Salt, butylated hydroxyanisol (antioxidant) and water were added to the flour mixture. A smooth sheath of dough 0.1 mm thick was prepared with a kitchen model Pasta machine and cut into 3.8 mm diameter and fried. Chips were salted or unsalted and held under nitrogen gas or air for 0, 3, 6 and 9 weeks storage. Unsalted chips without storage were analyzed for proximate composition, gross energy and minerals. Analyses of beta-carotene, peroxide value (PV), color and texture were made on chips during each week of

storage. Sensory evaluation was performed only on chips stored 9 weeks.

From this study the following conclusions may be made:

1. Chips prepared with FSPF have greater crude protein content (mean 5.00 g/100g) than chips with FSPS (mean 1.54 g/100g). Crude fat content of both types of chips was appreciably lower (mean 16.56 g/100g) than that (52.3%) for chips prepared from SP flesh by other researchers.

2. Chips produced with 100% FSPF or FSPS contained the greatest retinol equivalent (RE); chips with 25% SP flour (SPF), the lowest RE. Nitrogen gas atmosphere of the package of chips was more effective than air atmosphere in retention of beta-carotene of chips (reported herein as RE). Salted chips exhibited lower RE than unsalted chips. Extending the storage periods of chips decreased RE. There was 11.93% decrease in RE from 0 week of storage to 9 weeks storage of chips with FSPF and 5.97% for chips with FSPS. Chips with FSPF had an average 3.9 times more RE than chips with FSPS.

3. Both types of chips contained appreciable levels of potassium. Sodium content of salted chips with FSPF was 16.2 times higher than that of unsalted chips and 15.0 times more than that for unsalted chips with FSPS.

4. PV increased with an increase in levels of FSPF or FSPS. All salted chips held under nitrogen gas had lower

PV than unsalted chips under air. Chips with FSPS stored 9 weeks had greater PV (18.08 meg/kg fat) compared to unstored chips analyzed on the day of production (4.23 meg/kg fat).

5. Incorporation of 100% SPF into the formulation gave the firmest chips. Firmness of both types of chips increased with increase in SPF. Chips with FSPF or FSPS became firmer when stored in air atmosphere than nitrogen gas atmosphere. Levels of salt did not affect firmness of both types of chips.

6. Increasing the levels of SPF decreased the Hunter L values (lightness) and increased Hunter 'a' values (redness) and Hunter 'b' values (yellowness) of all chips. Generally, salted chips held under nitrogen gas were darker, redder and yellower than unsalted chips held under air. As storage period progressed, all chips became lighter and less red and yellow.

7. Panelists preferred the color, texture and overall acceptability of chips prepared with 25 and 50% SPF. With scores on a sensory scale of 1-8; 1 = dislike extremely, 8 = like extremely, average scores of chips with 25 and 50% SPF were: for color, 6.24 for chips with FSPF and 4.98 for chips with FSPS; for texture, 5.88 for chips with FSPF and 5.05 for chips with FSPS; for overall acceptability, 5.87, for chips with FSPF and 4.80 for chips with FSPS. Color, texture and overall acceptability of salted chips with both SPF held under nitrogen gas were

generally preferred over unsalted chips held under an air atmosphere. Chips with FSPF received greater sensory scores (were more preferred) than chips with FSPS.

8. The findings from this study suggested that chips prepared with SPF may be accepted by the consuming public. Bearing in mind that sensory studies were carried out on chips that were stored 9 weeks, it may be fair to assume that these chips were of satisfactory quality. In comparison to white potato chips currently marketed, this product exhibited an appreciable amount of beta-carotene (vitamin A precursor).

9. Additional studies are needed to determine at which storage period panelists begin to detect deterioration in chips.

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## REFERENCES

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**APPENDIX**  
**MEAN TABLES A - L**

Table A - Retinol equivalents of chips prepared with flour of sweet potato flesh (FSPF) and white potato as affected by the interaction levels of sweet potato x storage periods x levels of salt x gaseous atmospheres

| Levels of<br>FSPF, % <sup>a</sup> | Storage,<br>weeks | Salted                                       |                 | Unsalted |                 |
|-----------------------------------|-------------------|----------------------------------------------|-----------------|----------|-----------------|
|                                   |                   | Air                                          | Nitrogen<br>gas | Air      | Nitrogen<br>gas |
|                                   |                   | - - - - - RE/100g DWB <sup>b</sup> - - - - - |                 |          |                 |
| 25                                | 0                 | 330.71                                       | 350.74          | 338.67   | 317.17          |
|                                   | 3                 | 269.21                                       | 341.50          | 299.00   | 283.15          |
|                                   | 6                 | 268.73                                       | 317.68          | 285.49   | 245.41          |
|                                   | 9                 | 249.12                                       | 299.98          | 269.65   | 219.32          |
| 50                                | 0                 | 476.40                                       | 395.62          | 440.65   | 523.12          |
|                                   | 3                 | 409.92                                       | 381.48          | 395.91   | 465.81          |
|                                   | 6                 | 345.61                                       | 349.79          | 360.51   | 405.23          |
|                                   | 9                 | 334.91                                       | 313.91          | 323.70   | 357.23          |
| 75                                | 0                 | 715.11                                       | 696.00          | 715.54   | 709.07          |
|                                   | 3                 | 590.23                                       | 667.59          | 626.59   | 577.18          |
|                                   | 6                 | 504.43                                       | 598.15          | 593.96   | 552.46          |
|                                   | 9                 | 461.66                                       | 586.03          | 563.21   | 496.68          |
| 100                               | 0                 | 877.70                                       | 971.34          | 883.31   | 868.34          |
|                                   | 3                 | 749.09                                       | 893.54          | 872.15   | 844.57          |
|                                   | 6                 | 689.91                                       | 866.54          | 817.62   | 813.83          |
|                                   | 9                 | 622.81                                       | 872.57          | 771.96   | 790.95          |

N = 3.

<sup>a</sup> Percentage sweet potato flour based on amount of white potato flour.

<sup>b</sup> RE/100g DWB indicate retinol equivalent per 100 g calculated on dry weight basis.

Table B - Retinol equivalent of chips prepared with flour of sweet potato skin (FSPS) and white potato as affected by the interactions levels of sweet potato x storage periods x levels of salt x gaseous atmospheres

| Levels of<br>FSPS, % <sup>a</sup> | Storage,<br>weeks | Salted                                       |          | Unsalted |          |
|-----------------------------------|-------------------|----------------------------------------------|----------|----------|----------|
|                                   |                   | Air                                          | Nitrogen | Air      | Nitrogen |
|                                   |                   | gas                                          |          | gas      |          |
|                                   |                   | - - - - - RE/100g DWB <sup>b</sup> - - - - - |          |          |          |
| 25                                | 0                 | 105.73                                       | 103.92   | 106.73   | 109.45   |
|                                   | 3                 | 107.23                                       | 103.04   | 107.63   | 107.61   |
|                                   | 6                 | 97.70                                        | 95.53    | 103.16   | 103.86   |
|                                   | 9                 | 83.57                                        | 93.99    | 95.89    | 100.34   |
| 50                                | 0                 | 115.99                                       | 118.46   | 115.71   | 123.67   |
|                                   | 3                 | 115.65                                       | 116.21   | 110.73   | 118.29   |
|                                   | 6                 | 107.70                                       | 111.20   | 108.64   | 113.39   |
|                                   | 9                 | 98.67                                        | 109.43   | 88.65    | 114.93   |
| 75                                | 0                 | 154.85                                       | 142.74   | 140.29   | 146.46   |
|                                   | 3                 | 155.85                                       | 140.12   | 134.69   | 143.52   |
|                                   | 6                 | 144.03                                       | 136.24   | 132.81   | 140.65   |
|                                   | 9                 | 134.94                                       | 127.43   | 125.12   | 133.47   |
| 100                               | 0                 | 200.89                                       | 181.90   | 200.11   | 197.83   |
|                                   | 3                 | 199.03                                       | 178.47   | 198.57   | 195.84   |
|                                   | 6                 | 187.85                                       | 172.29   | 189.03   | 193.66   |
|                                   | 9                 | 179.68                                       | 163.88   | 176.80   | 188.52   |

N = 3.

<sup>a</sup> Percentage sweet potato flour based on amount of white potato flour.

<sup>b</sup> RE/100g DWB indicates retinol equivalent per 100 gram calculated on dry weight basis.

Table C - Peroxide values of chips prepared with flour of sweet potato flesh (FSPF) as affected by the interaction levels of sweet potato x storage periods x levels of salt x gaseous atmospheres

| Levels of<br>FSPF, % <sup>a</sup>           | Storage,<br>weeks | Salted |                 | Unsalted |                 |
|---------------------------------------------|-------------------|--------|-----------------|----------|-----------------|
|                                             |                   | Air    | Nitrogen<br>gas | Air      | Nitrogen<br>gas |
| - - - - - meq/kg DWB <sup>b</sup> - - - - - |                   |        |                 |          |                 |
| 25                                          | 0                 | 4.34   | 3.87            | 3.87     | 3.87            |
|                                             | 3                 | 10.34  | 9.07            | 11.71    | 8.10            |
|                                             | 6                 | 14.74  | 10.61           | 17.25    | 10.61           |
|                                             | 9                 | 19.55  | 13.94           | 21.15    | 15.78           |
| 50                                          | 0                 | 3.50   | 3.54            | 4.20     | 4.87            |
|                                             | 3                 | 10.77  | 8.71            | 12.24    | 8.94            |
|                                             | 6                 | 14.61  | 11.87           | 16.94    | 11.14           |
|                                             | 9                 | 18.91  | 14.34           | 21.58    | 15.81           |
| 75                                          | 0                 | 4.27   | 3.80            | 6.00     | 4.40            |
|                                             | 3                 | 12.44  | 9.21            | 12.01    | 9.84            |
|                                             | 6                 | 15.64  | 12.34           | 16.05    | 12.94           |
|                                             | 9                 | 19.95  | 15.98           | 20.21    | 16.58           |
| 100                                         | 0                 | 4.40   | 3.84            | 5.14     | 4.14            |
|                                             | 3                 | 12.17  | 9.14            | 12.84    | 8.47            |
|                                             | 6                 | 15.08  | 11.74           | 17.95    | 12.81           |
|                                             | 9                 | 20.71  | 15.44           | 22.55    | 16.74           |

N = 3.

<sup>a</sup> Percentage sweet potato flour based on amount of white potato flour.

<sup>b</sup> meq/kg fat DWB indicates milliequivalents per kg fat calculated on dry weight basis.

Table D - Peroxide values of chips prepared with flour of sweet potato skin (FSPS) and white potato as affected by the interaction levels of sweet potato x storage periods x levels of salt x gaseous atmospheres

| Levels of<br>FSPS, % <sup>a</sup>           | Storage,<br>weeks | <u>Salted</u> |                 | <u>Unsalted</u> |                 |
|---------------------------------------------|-------------------|---------------|-----------------|-----------------|-----------------|
|                                             |                   | Air           | Nitrogen<br>gas | Air             | Nitrogen<br>gas |
| - - - - - meq/kg DWB <sup>b</sup> - - - - - |                   |               |                 |                 |                 |
| 25                                          | 0                 | 3.80          | 2.67            | 4.20            | 3.74            |
|                                             | 3                 | 10.81         | 7.81            | 10.84           | 7.74            |
|                                             | 6                 | 11.84         | 8.97            | 14.98           | 9.74            |
|                                             | 9                 | 15.85         | 10.94           | 19.15           | 12.67           |
| 50                                          | 0                 | 4.27          | 3.17            | 4.04            | 3.70            |
|                                             | 3                 | 10.11         | 8.57            | 11.57           | 7.81            |
|                                             | 6                 | 12.88         | 9.17            | 14.71           | 10.91           |
|                                             | 9                 | 18.15         | 11.17           | 19.61           | 12.67           |
| 75                                          | 0                 | 3.64          | 3.14            | 4.30            | 4.04            |
|                                             | 3                 | 10.07         | 9.81            | 11.27           | 7.47            |
|                                             | 6                 | 13.34         | 10.12           | 13.91           | 11.94           |
|                                             | 9                 | 18.01         | 12.27           | 19.71           | 13.84           |
| 100                                         | 0                 | 4.30          | 3.60            | 4.37            | 4.34            |
|                                             | 3                 | 10.61         | 9.91            | 11.51           | 9.04            |
|                                             | 6                 | 12.71         | 10.54           | 14.38           | 12.67           |
|                                             | 9                 | 17.31         | 14.58           | 19.71           | 13.27           |

N = 3.

<sup>a</sup> Percentage sweet potato flour based on amount of white potato flour.

<sup>b</sup> meq/kg fat DWB indicates milliequivalents per kilogram fat calculated on dry weight basis.



Table E - Firmness of chips prepared with flour of sweet potato flesh (FSPF) and white potato as affected by the interaction levels of sweet potato x storage periods x levels of salt x gaseous atmospheres

| Levels of<br>FSPF, % <sup>a</sup> | Storage,<br>weeks | Salted |          | Unsalted |          |
|-----------------------------------|-------------------|--------|----------|----------|----------|
|                                   |                   | Air    | Nitrogen | Air      | Nitrogen |
|                                   |                   | gas    |          | gas      |          |
| - - - - - grams force - - - - -   |                   |        |          |          |          |
| 25                                | 0                 | 480    | 473      | 466      | 466      |
|                                   | 3                 | 483    | 420      | 480      | 440      |
|                                   | 6                 | 517    | 421      | 510      | 446      |
|                                   | 9                 | 517    | 446      | 510      | 453      |
| 50                                | 0                 | 743    | 763      | 710      | 696      |
|                                   | 3                 | 727    | 746      | 713      | 686      |
|                                   | 6                 | 743    | 713      | 723      | 666      |
|                                   | 9                 | 757    | 720      | 727      | 642      |
| 75                                | 0                 | 827    | 813      | 818      | 806      |
|                                   | 3                 | 836    | 806      | 823      | 823      |
|                                   | 6                 | 810    | 796      | 807      | 830      |
|                                   | 9                 | 813    | 806      | 720      | 873      |
| 100                               | 0                 | 900    | 883      | 900      | 886      |
|                                   | 3                 | 896    | 846      | 890      | 916      |
|                                   | 6                 | 876    | 853      | 916      | 923      |
|                                   | 9                 | 913    | 873      | 920      | 930      |

N = 3.

<sup>a</sup> Percentage sweet potato flour based on amount of white potato flour.

Table F - Firmness of chips prepared with flour of sweet potato skin (FSPS) and white potato as affected by the interaction levels of sweet potato x storage periods x levels of salt x gaseous atmospheres

| Levels of<br>FSPS, % <sup>a</sup> | Storage,<br>weeks | <u>Salted</u> |                 | <u>Unsalted</u> |                 |
|-----------------------------------|-------------------|---------------|-----------------|-----------------|-----------------|
|                                   |                   | Air           | Nitrogen<br>gas | Air             | Nitrogen<br>gas |
| - - - - - grams force - - - - -   |                   |               |                 |                 |                 |
| 25                                | 0                 | 366           | 346             | 350             | 320             |
|                                   | 3                 | 377           | 340             | 360             | 353             |
|                                   | 6                 | 380           | 343             | 380             | 363             |
|                                   | 9                 | 393           | 360             | 383             | 370             |
| 50                                | 0                 | 430           | 436             | 430             | 430             |
|                                   | 3                 | 456           | 473             | 447             | 447             |
|                                   | 6                 | 457           | 497             | 463             | 446             |
|                                   | 9                 | 460           | 496             | 456             | 441             |
| 75                                | 0                 | 453           | 430             | 463             | 466             |
|                                   | 3                 | 446           | 446             | 466             | 476             |
|                                   | 6                 | 476           | 447             | 473             | 477             |
|                                   | 9                 | 497           | 460             | 480             | 483             |
| 100                               | 0                 | 490           | 467             | 493             | 466             |
|                                   | 3                 | 490           | 490             | 500             | 463             |
|                                   | 6                 | 487           | 487             | 503             | 477             |
|                                   | 9                 | 507           | 496             | 503             | 490             |

N = 3.

<sup>a</sup> Percentage sweet potato flour based on amount of white potato flour.

Table G - Hunter L values of chips prepared with flour of sweet potato flesh (FSPF) and white potato as affected by the interaction levels of sweet potato x storage periods x levels of salt x gaseous atmospheres

| Levels of<br>FSPF, % <sup>a</sup> | Storage,<br>weeks | Salted |                 | Unsalted |                 |
|-----------------------------------|-------------------|--------|-----------------|----------|-----------------|
|                                   |                   | Air    | Nitrogen<br>gas | Air      | Nitrogen<br>gas |
| 25                                | 0                 | 56.73  | 56.37           | 57.07    | 57.13           |
|                                   | 3                 | 58.37  | 56.57           | 58.10    | 57.03           |
|                                   | 6                 | 60.67  | 57.80           | 58.00    | 57.63           |
|                                   | 9                 | 61.00  | 57.53           | 59.20    | 57.7            |
| 50                                | 0                 | 54.67  | 54.03           | 56.13    | 53.80           |
|                                   | 3                 | 56.13  | 54.93           | 57.07    | 54.43           |
|                                   | 6                 | 57.93  | 55.33           | 58.30    | 54.37           |
|                                   | 9                 | 59.10  | 56.40           | 58.87    | 54.53           |
| 75                                | 0                 | 51.07  | 50.20           | 52.27    | 50.77           |
|                                   | 3                 | 52.93  | 50.10           | 53.40    | 51.40           |
|                                   | 6                 | 53.10  | 51.07           | 55.47    | 51.30           |
|                                   | 9                 | 54.03  | 51.93           | 58.03    | 51.10           |
| 100                               | 0                 | 46.93  | 47.90           | 47.23    | 47.67           |
|                                   | 3                 | 46.93  | 47.97           | 49.03    | 49.50           |
|                                   | 6                 | 45.10  | 47.53           | 49.77    | 48.23           |
|                                   | 9                 | 42.57  | 50.13           | 52.13    | 48.23           |

N = 3.

<sup>a</sup> Percentage sweet potato flour based on amount of white potato flour.

Table H - Hunter 'a' values of chips prepared with flour of sweet potato flesh (FSPF) and white potato as affected by the interaction levels of sweet potato x storage periods x levels of salt x gaseous atmospheres

| Levels of FSPF, % <sup>a</sup> | Storage, weeks | Salted |              | Unsalted |              |
|--------------------------------|----------------|--------|--------------|----------|--------------|
|                                |                | Air    | Nitrogen gas | Air      | Nitrogen gas |
| 25                             | 0              | 7.83   | 7.43         | 7.87     | 8.57         |
|                                | 3              | 7.67   | 7.30         | 7.77     | 8.73         |
|                                | 6              | 7.37   | 7.37         | 7.33     | 8.63         |
|                                | 9              | 7.33   | 7.77         | 7.10     | 8.37         |
| 50                             | 0              | 8.57   | 10.30        | 8.83     | 9.53         |
|                                | 3              | 7.90   | 10.10        | 8.23     | 9.43         |
|                                | 6              | 7.63   | 10.30        | 7.87     | 9.40         |
|                                | 9              | 7.63   | 10.27        | 7.43     | 9.40         |
| 75                             | 0              | 10.08  | 12.20        | 10.03    | 12.00        |
|                                | 3              | 9.60   | 11.20        | 9.30     | 11.97        |
|                                | 6              | 9.23   | 11.13        | 8.93     | 11.73        |
|                                | 9              | 9.20   | 10.17        | 8.43     | 11.57        |
| 100                            | 0              | 14.07  | 15.73        | 13.00    | 14.87        |
|                                | 3              | 14.00  | 13.50        | 12.00    | 14.40        |
|                                | 6              | 13.40  | 13.10        | 11.60    | 13.93        |
|                                | 9              | 13.40  | 14.10        | 10.20    | 13.73        |

N = 3.

<sup>a</sup> Percentage sweet potato flour based on amount of white potato flour.

Table I - Hunter 'b' values of chips prepared with flour of sweet potato flesh (FSPF) and white potato as affected by the interaction levels of sweet potato x storage periods x levels of salt x gaseous atmospheres

| Levels of FSPF, % <sup>a</sup> | Storage, weeks | Salted |              | Unsalted |              |
|--------------------------------|----------------|--------|--------------|----------|--------------|
|                                |                | Air    | Nitrogen gas | Air      | Nitrogen gas |
| 25                             | 0              | 27.13  | 25.50        | 26.93    | 23.20        |
|                                | 3              | 26.37  | 27.50        | 26.57    | 22.80        |
|                                | 6              | 24.53  | 27.23        | 26.87    | 23.07        |
|                                | 9              | 24.63  | 27.50        | 26.37    | 23.50        |
| 50                             | 0              | 27.83  | 26.60        | 25.33    | 23.93        |
|                                | 3              | 25.87  | 28.30        | 25.00    | 23.80        |
|                                | 6              | 25.00  | 28.13        | 24.67    | 23.70        |
|                                | 9              | 24.93  | 27.57        | 24.23    | 24.07        |
| 75                             | 0              | 27.93  | 28.20        | 26.47    | 25.13        |
|                                | 3              | 27.00  | 29.03        | 24.37    | 24.80        |
|                                | 6              | 26.40  | 28.67        | 22.90    | 25.10        |
|                                | 9              | 26.03  | 27.40        | 22.70    | 24.73        |
| 100                            | 0              | 29.10  | 26.90        | 27.97    | 26.93        |
|                                | 3              | 28.43  | 26.03        | 27.00    | 26.47        |
|                                | 6              | 26.53  | 25.67        | 25.63    | 26.03        |
|                                | 9              | 26.03  | 28.53        | 26.13    | 25.77        |

N = 3.

<sup>a</sup> Percentage sweet potato flour based on amount of white potato flour.

Table J - Hunter L values of chips prepared with flour of sweet potato skin (FSPS) and white potato as affected by the interaction levels of sweet potato x storage periods x levels of salt x gaseous atmospheres

| Levels of FSPS, % <sup>a</sup> | Storage, weeks | Salted |              | Unsalted |              |
|--------------------------------|----------------|--------|--------------|----------|--------------|
|                                |                | Air    | Nitrogen gas | Air      | Nitrogen gas |
| 25                             | 0              | 49.40  | 48.37        | 49.00    | 48.23        |
|                                | 3              | 51.53  | 47.53        | 49.93    | 49.00        |
|                                | 6              | 52.87  | 47.47        | 50.37    | 48.63        |
|                                | 9              | 53.83  | 48.87        | 50.90    | 50.73        |
| 50                             | 0              | 47.87  | 48.00        | 44.47    | 47.90        |
|                                | 3              | 49.13  | 47.40        | 44.80    | 48.73        |
|                                | 6              | 53.30  | 47.83        | 45.87    | 49.17        |
|                                | 9              | 54.80  | 48.80        | 46.93    | 48.73        |
| 75                             | 0              | 45.40  | 44.83        | 41.47    | 45.90        |
|                                | 3              | 47.17  | 44.87        | 42.87    | 46.03        |
|                                | 6              | 49.73  | 46.23        | 43.33    | 46.67        |
|                                | 9              | 50.73  | 47.93        | 44.60    | 47.93        |
| 100                            | 0              | 42.33  | 41.40        | 39.60    | 42.90        |
|                                | 3              | 44.10  | 42.70        | 41.03    | 43.47        |
|                                | 6              | 47.10  | 44.00        | 41.77    | 43.77        |
|                                | 9              | 49.70  | 44.93        | 43.93    | 44.40        |

N = 3.

<sup>a</sup> Percentage sweet potato flour based on amount of white potato flour.

Table K - Hunter 'a' value of chips prepared with flour of sweet potato skin (FSPS) and white potato as affected by the interaction levels of sweet potato x storage periods x levels of salt x gaseous atmospheres

| Levels of FSPS, % <sup>a</sup> | Storage, weeks | Salted |              | Unsalted |              |
|--------------------------------|----------------|--------|--------------|----------|--------------|
|                                |                | Air    | Nitrogen gas | Air      | Nitrogen gas |
| 25                             | 0              | 9.10   | 8.67         | 8.70     | 8.70         |
|                                | 3              | 8.33   | 8.57         | 8.83     | 8.43         |
|                                | 6              | 8.07   | 8.13         | 8.40     | 8.07         |
|                                | 9              | 7.83   | 7.63         | 8.07     | 8.47         |
| 50                             | 0              | 10.87  | 10.47        | 10.00    | 10.23        |
|                                | 3              | 10.23  | 10.13        | 9.57     | 10.80        |
|                                | 6              | 9.23   | 9.80         | 9.07     | 10.17        |
|                                | 9              | 8.47   | 3.30         | 9.50     | 9.70         |
| 75                             | 0              | 11.93  | 12.03        | 11.50    | 12.30        |
|                                | 3              | 11.40  | 10.80        | 10.87    | 11.93        |
|                                | 6              | 10.17  | 9.93         | 10.40    | 11.37        |
|                                | 9              | 9.17   | 9.53         | 9.60     | 10.63        |
| 100                            | 0              | 13.70  | 13.87        | 12.87    | 13.80        |
|                                | 3              | 12.43  | 12.57        | 11.90    | 14.53        |
|                                | 6              | 11.43  | 11.37        | 11.77    | 13.03        |
|                                | 9              | 10.67  | 11.10        | 12.40    | 12.30        |

N = 3.

<sup>a</sup> Percentage sweet potato flour based on amount of white potato flour.

Table L - Hunter 'b' values of chips prepared with flour of sweet poato skin (FSPS) and white potato as affected by the interaction levels of sweet potato x storage periods x levels of salt x gaseous atmospheres

| Levels of<br>FSPS, % <sup>a</sup> | Storage,<br>weeks | Salted |                 | Unsalted |                 |
|-----------------------------------|-------------------|--------|-----------------|----------|-----------------|
|                                   |                   | Air    | Nitrogen<br>gas | Air      | Nitrogen<br>gas |
| 25                                | 0                 | 23.63  | 23.97           | 22.83    | 23.00           |
|                                   | 3                 | 24.90  | 24.07           | 23.47    | 23.30           |
|                                   | 6                 | 26.20  | 24.77           | 24.03    | 24.57           |
|                                   | 9                 | 27.67  | 25.90           | 25.00    | 24.73           |
| 50                                | 0                 | 26.43  | 26.73           | 23.73    | 26.53           |
|                                   | 3                 | 27.50  | 26.93           | 24.73    | 24.67           |
|                                   | 6                 | 28.97  | 28.87           | 23.13    | 29.03           |
|                                   | 9                 | 30.40  | 30.17           | 23.77    | 29.80           |
| 75                                | 0                 | 26.77  | 26.47           | 21.87    | 27.20           |
|                                   | 3                 | 28.33  | 27.57           | 23.07    | 28.03           |
|                                   | 6                 | 28.97  | 28.87           | 23.13    | 29.03           |
|                                   | 9                 | 30.40  | 30.17           | 23.77    | 29.80           |
| 100                               | 0                 | 27.23  | 28.60           | 21.00    | 29.03           |
|                                   | 3                 | 28.47  | 28.87           | 22.93    | 28.50           |
|                                   | 6                 | 28.97  | 29.60           | 24.17    | 29.40           |
|                                   | 9                 | 29.77  | 29.87           | 23.80    | 30.10           |

N = 3.

<sup>a</sup> Percentage sweet potato flour based on amount of white potato flour.



## VITA

Ignatius Uzo Manu was born January 1, 1955, in Owerri, Imo State, Nigeria. In September 1978, he enrolled in the Food Technology and Science Department of Alabama A&M University, Normal Alabama as an undergraduate. He received a Bachelor of Science (with honors) in 1981 and Master of Science in 1981. In September of 1984, he entered the Ph.D program in the Food Technology and Science Department of the University of Tennessee, Knoxville, Tennessee, and since then he has been working towards completion of the program. He worked to pay school fees during the Ph.D program.

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