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A Quantitative Analysis of Potassium Loss As a Result of Different Processing Methods

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A QUANTITATIVE ANALYSIS OF POTASSIUM LOSS AS A RESULT OF DIFFERENT PROCESSING METHODS

by

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ABSTRACT

A Quantitative Analysis of Potassium Loss As a

Result of Different Processing Methods

by

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Utah State University, 1997

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Compliance with the strict dietary regimen for the dialysis patient can be very challenging. Many foods are limited from the diet of a renal patient because of the high potassium content. The physiological consequences of failure to follow a diet prescription can be fatal for the dialysis patient. In an effort to improve patient compliance with nutritional protocols, several potato cooking methods and centrifugation of tomato sauce were investigated for their effects in reducing potassium content.

All methods with a 24-hour soak were found to be significant in reducing potassium content of potatoes ($P<0.05$). However, some of the methods in which the potatoes were not soaked were also found to be effective in reducing potassium content. Slice thickness and volume of cooking water used were found to be two important factors in determining potassium loss. The 4-mm sliced potatoes, which had a mean potassium value of 84 mg/100 g, lost more potassium than the 8-mm sliced potatoes with a mean potassium value of 182 mg/100 g ($P<0.05$). Furthermore, the potatoes cooked in 10 times the amount of water lost more potassium (124 mg/100 g) than those cooked in only 5 times the amount of water (148 mg/100 g) ($P<0.05$). Soaking in cold versus hot water, agitation of the soak water, or the addition of chemical chelators to the soak water were not shown to be any more effective in reducing the potassium content than the other methods. Sensory data indicated that participants did not have a strong taste preference for potatoes cooked by any one particular method ($P<0.05$).

Centrifugation of tomato sauce, and retention of the solids were found to be effective methods for reducing the potassium content of tomato sauce. There was, however, a significant difference ($P<0.05$) in the participants' taste preference for the tomato sauce that was centrifuged one time versus the tomato sauce that had been centrifuged twice.

The results of this study are significant because they suggest that there are more effective, alternative methods for preparing potatoes and tomato sauce than those that are currently being used. This would suggest an increased likelihood for patient adherence to nutritional recommendations.

(83 pages)

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Patti M. Klefbeck

CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

According to the United States Renal Data System (USRDS), in 1995, the prevalence of end stage renal disease (ESRD) in the U.S. was nearly 300,000 patients (1). This number has been estimated to increase at a rate of 7% each year, with the three leading causes of ESRD being diabetes, hypertension, and glomerulonephritis (1).

ESRD is characterized by the progressive, irreversible loss of nephron function. As the number of functioning nephrons decreases, the remaining intact nephrons increase in size and function in an effort to compensate and maintain homeostasis. Eventually, these nephrons fail, and the kidney ceases to function (2). Chronic renal failure leads to progressive inability of the kidney to excrete the end products of protein metabolism such as urea, sulfates, and phosphates; minerals such as magnesium and calcium; and the electrolytes sodium and potassium. The kidneys are very important organs in the human body and perform a wide range of functions. Among these roles are:

1. Endocrine functions
2. Acid-Base balance through the regulation of hydrogen ion concentration
3. Excretion of metabolic wastes
4. Maintaining fluid homeostasis and osmolality
5. Regulation of potassium balance
6. Regulation of calcium and phosphorous balance (2).

The functional kidney has the ability to balance fluids, electrolytes, and organic solutes over a wide range of dietary fluctuations in sodium, water, and various solutes. This is done by continuous filtration of the blood. For individuals with ESRD, their kidneys can no longer perform these vital functions; hence, they require either dialysis or a kidney transplant to prolong their life.

Dialysis is a process of diffusion and filtration between solutions separated by a semi-permeable membrane; blood is circulated on one side of the semi-permeable membrane and a cleansing fluid, known as the dialysate, on the other. Through this exchange of fluids, waste products that have accumulated in the blood are removed by diffusion (3). Dialysis has been shown to improve the condition of most patients in end-stage renal disease (1-3). Since the kidneys are unable to clear wastes from the body, dialysis patients are frequently required to carefully monitor and control their intake of fluids, protein, potassium, phosphorous, sodium, and calcium. Proper nutrition takes on a significant role in the well-being of the dialysis patient. Compliance with dietary, fluid, and medication instruction is a critically significant factor in the continued health of the patient undergoing dialysis treatment. Adherence to these requirements within the dialysis population is poor, with less than 25% of the patient population meriting a good compliance rating (4).

Nutritional management is of paramount importance in chronic renal failure and plays a vital role in the ESRD patient's well-being. The physiological consequences of failure to follow a diet prescription can be severe and even fatal for the renal patient. Consequently, the preservation of the kidneys in a patient with ESRD undergoing dialysis is no longer of nutritional concern--they are already destroyed. Instead, the nutritional care must be focused on balancing between what is provided in the diet and what is removed by dialysis. Because ESRD patients are often placed on fluid and food restrictions, this makes meal planning a challenging task and can also greatly detract from the patient's quality of life.

Failure to comply with dietary restrictions can result in serious problems. The importance of compliance cannot be overemphasized. In a 1970 survey of 201 hemo-dialysis facilities in the United States, Abram and co-workers (5) found a suicide incidence rate of more than four hundred times that of the normal population. Furthermore, of the 3,478 patients, 192 exhibited life-threatening behavior. As a result, 117 patients died as a consequence of noncompliance with the treatment regimen, especially the inclusion of forbidden fluids and foods.

Noncompliance among the hemo-dialysis population is very common. Various studies have reported between 25% and 81% of chronic hemo-dialysis patients as being noncompliant (4,6-8). Moreover, compliance is not associated significantly with a patient's level of knowledge regarding the prescribed regimen (9). Patients have been found to comply with some recommendations, and at the same time, abuse other aspects of the program (10). In regard to aspects of the dietary treatment of ESRD, it has been noted that intelligence has little influence on compliance (11). However, researchers did find a strong relationship between the patients' understanding of the restrictions and compliance. The question of how to improve compliance among these individuals is a difficult and complicated one to answer. Certainly, there is not one single factor, but rather a number of factors that are involved in determining whether or not an individual will comply with an outlined regimen.

Potassium is the major intracellular cation in the body and is crucial for normal cellular activity. It serves a variety of important functions in energy metabolism, membrane transport, and maintenance of the potential difference across cell membranes (3). Potassium enters the body through the diet and is eliminated almost exclusively by the kidneys under normal circumstances. An increase in extracellular potassium concentration (hyperkalemia) may occur because of either increased potassium intake, decreased renal excretion of potassium, or a shift in potassium balance across cell membranes from the inside to the outside of cells (3). Hyperkalemia may cause the cell to be nonfunctional. Symptoms of hyperkalemia are weakness, lethargy, cardiac arrhythmias, and conduction disturbances (2). Cardiac arrhythmias and conduction disturbances can be deadly because of failure of the heart to perfuse blood through the vascular tissue. Control of dietary potassium is essential for the dialysis patient because in ESRD the kidney is no longer capable of performing its normal functions, and potassium can be removed from the body only by dialysis. Dialysis does not continuously cleanse the blood, so toxic levels of potassium can build up between dialysis treatments. As a result, dialysis patients are commonly placed on potassium restrictions of 1,000 mg (25 mEq) to 2,800 mg (72 mEq) per day.

Fruits and vegetables are a major source of potassium in the diet (12). Dietary data from 11,568 adult respondents in the second National Health and Nutrition Examination Survey (NHANES II) were used to provide quantitative information regarding the contribution of specific foods to the total population intake of 10 nutrients (13). Potassium was among the 10 nutrients listed. Among the top 50 major contributors of potassium in the US diet were potatoes, tomatoes, tomato juice, spaghetti with tomato sauce, tomato soup, and pizza. As a result of their high potassium content, foods such as these are frequently omitted from the diet of renal failure patients. With the exception of calcium, the potato is a significant source of minerals for which the recommended daily allowances have been established (iron, copper, iodine, magnesium, phosphorous, and zinc). Since potatoes provide numerous essential dietary factors (14), it is of importance to allow the dialysis patient the use of this vegetable. Tomato sauce can also serve as a base for a wide variety of foods; hence, being able to extract potassium from any of these foods would increase their potential use by many dialysis patients.

This research was undertaken in an effort not only to provide an easier and less time consuming method for preparing reduced potassium potatoes, but also to develop a low potassium tomato sauce. In the case of potatoes, it is anticipated that by identifying a method that minimizes and facilitates preparation time that patients will more likely be compliant with nutritional protocols that require a reduced potassium intake. Furthermore, there is currently not a commercially available tomato sauce product that uses real tomatoes and has a lowered potassium content. Hence, my purpose in developing the tomato sauce product is to be able to provide to ESRD patients a commercial tomato sauce product that is not only palatable but also affordable.

LITERATURE REVIEW

To the best of my knowledge, no research studies have been conducted to *maximize* nutrient losses. In fact, improving nutritional values rather than reducing them is a major objective of research in agriculture today.

Potatoes constitute a major food that most of the United States population consumes freely. It is a major vegetable crop in many parts of the world and a staple food for humans with an annual per capita consumption of 110-120 pounds (14). Potatoes are among the foods richest in potassium. In potatoes, potassium plays an important role in the susceptibility of the potato to enzymatic discoloration or black spots (15). Thus, from the perspective of the potato farmer, it is not reasonable to produce a low potassium potato. Wide variations in the mineral content of potatoes have been attributed to:

1. Differences in soil type
2. Differences in the mineral content of the soil
3. Varietal differences (16).

Furthermore, researchers have shown that tuber potassium concentrations increased with both soil and fertilizer potassium (17). Nevertheless, tuber potassium concentrations in low potassium soils remained lower than in potatoes grown in high potassium soils, even when sufficient fertilizer was added. This fact suggests that soil potassium is more readily available than fertilizer potassium. Additionally, the mineral contents of cortex and pith tissues within the same potato differ. Minerals are often found highly concentrated in the outer cortical region of the potato (18). Several different groups of researchers have reported that progressing from the outer epidermis towards the pith, there was a decrease in magnesium, phosphorous, potassium, and calcium (19-20). Furthermore, Mondy and Ponnampalam (18) investigated the effects of frying on the mineral content of Katahdin, Chipbelle, and Rosa varieties of potatoes and found that in all three varieties, movement of potassium, phosphorous, and iron was demonstrated during conventional baking. Conventional baking increased the potassium content in the pith by 14%-23%. This apparent movement of minerals toward the interior is in agreement with the findings observed for nitrogen constituents (21). These researchers also suggested that the higher potassium concentrations in the pith tissues are probably due to dehydration and cellular damage of cortex tissue from prolonged heating, thereby causing a diffusion gradient for the movement of potassium from the cortex to the pith.

It has been well established that cooking losses of nutrients from potatoes are greatest when the peel is removed (22-32). Several research experiments (24-26, 29) have indicated that when peeled or even unpeeled potatoes were boiled in water, 10-50% of the potassium was lost, depending on the size of the potato, the cooking time, and the concentration of sodium in the water. The same general results have been found for carrots, beans, and peas. In 1897, the Office of Experiment Stations published Bulletin No. 42 (31). This contained a report on the vitamin and mineral losses that occurred during boiling of vegetables; those chosen for the investigation were potatoes, carrots, and cabbage. The conclusions drawn from the results of this work emphasized that nutrient loss was greatest in the peeled potatoes and those that were soaked prior to cooking. Similarly, potatoes boiled in their skins were found to lose 3% of their potassium, as compared to 38% of their potassium when they are boiled after peeling. Unfortunately, much of the research on nutrient losses during cooking was conducted in the early 1900s and does not describe in detail the method of cooking. Furthermore, cooking parameters, e.g., times and temperatures, size of potato pieces, etc., are often not specified, which makes it difficult to compare results of different investigations.

After reviewing the literature, I feel there are three significant factors that contribute to variations in cooking losses. These are:

1. Length of cooking period
2. Slice thickness
3. Amount of cooking water.

Nutrient losses increase as the ratio of cooking water to food increases, and as the cooking time increases (27). Denton (22) reported that preliminary soaking in cold water or starting the cooking process in cold instead of in boiling water would greatly increase cooking losses by prolonging the period of cooking. Additionally, Tsaltas (33) reported that keeping time and temperature components constant, potassium was not effectively leached from tuberous vegetables (such as potatoes, beets, and carrots) unless they were sliced to approximately 2-3 mm (1/8 of an inch) thickness. A comprehensive study was conducted to look at the effect of home preparation on the vitamin and mineral content of 20 common foods (29). They reported that the loss of most nutrients was greatest when the volume of cooking water was large, the time of cooking was long, and the size of food particle was small.

It has been suggested that by shortening the cooking time through the use of pressure cooking, the extraction and destruction of nutrients can be reduced significantly

(27). In fact, some researchers have found that the loss of nutrients is considerably less during pressure cooking of vegetables than during boiling at atmospheric pressures (28). One group of researchers placed vegetables above the cooking water in a pressure cooker and maintained pressure at 15 pounds for 15 minutes (34). Although the figures varied considerably among the vegetables, they found the approximate average losses for magnesium, iron, and phosphorous to be 20% by steaming and pressure cooking, 30% by boiling in a moderate quantity of water, and 45% when double this quantity of water was used.

Several studies have been conducted on the losses of nutrients as a result of various commercial processes (18,30,32,35). As mentioned earlier, most of the research in this area describes, in any single test, the changes in the composition of only a few closely related products, and usually for one, or only a few nutritional components at one time. Furthermore, cooking parameters, e.g., times and temperatures, size of potato pieces, etc., are often not specified. According to USDA Handbook 8 (12), granules contained 73% less potassium, and flakes contained 57% less potassium than an equal weight of raw potatoes. Similarly, Weaver et al. (32) found that potatoes made from granules contained 51% less potassium, and flakes contained 63% less potassium than an equal weight of raw potatoes. These researchers concluded that the prolonged time of cooking used in the preparation of potato tissue for dehydrated flakes and granules caused the loss of more nutrients than the less extensive cooking time used for home-boiled potatoes (32). Mueller (30), however, reported only a 24-26% loss of potassium when potatoes were processed into flakes or granules.

A chelating agent is a negatively charged compound capable of forming a strong ring structure that is capable of incorporating a metal ion, thereby preventing it from entering many unwanted reactions (36). Thus, chelating agents control and deactivate positively charged metal ions by forming a new compound that is a neutral or negatively charged anion. For instance, calcium (Ca^{2+}) is chelated by the common chelating agent, ethylenediaminetetraacetate ($EDTA^{4-}$), to form a new compound ($CaEDTA^{2-}$) that is highly soluble and will not react with common precipitants for calcium such as carbonates or sulfates (36).

Taken as a whole, the literature supports the fact that when home-scale portions of vegetable foods are prepared, nutrient losses vary according to:

1. The type of food
2. The stability of the nutrient
3. The duration of cooking time
4. The type of equipment
5. Size (surface area) of vegetable
6. Volume of cooking water.

MATERIALS AND METHODS

In this research study, potatoes were obtained from two different sources, namely, a local grocery store in Logan, Utah, and a processing plant in Washington state. Preliminary testing found that the initial potassium values for these potatoes were 542 mg/100 g for the Washington state potatoes and 384 mg/100 g for the Logan, Utah potatoes.

Twenty pounds of Russet potatoes grown in Rigby, Idaho were obtained from a local grocery store in Logan, Utah. Prior to processing, all potatoes were rinsed, peeled, and randomly sliced to a specified thickness. A fold-up electric food slicer by Rival, model #1042, was used to slice all potatoes.

Twenty-five potatoes were untreated and used to obtain a control potassium value. This was done to account for the variability in potassium values between different potatoes. The average initial potassium value was 384 mg/100 g wet weight (Appendix C, Table C.1). The specific steps within the individual groups are given below.

Potato Cooking Methods

Preparation of Logan, Utah Potatoes

Three groups of five potatoes were randomly sliced into three different thicknesses: 4 mm, 6 mm, and 8 mm. These three slicing thickness groups were then divided into several more groups based on treatment: no soak, 2-hour soak, 24-hour soak; and volume of cooking water: 1 liter (five times the amount of cooking water as potatoes), and 2 liters (10 times the amount of cooking water as potatoes). Each treatment group had approximately 1 cup (200 g) of potatoes. When a soaking period was used, potatoes were soaked in 2 liters of water, i.e., 10 times the amount of water as potato. For the 2-hour soaking period, the water was changed after 1 hour, and all of the soak water was discarded prior to cooking.

Pressure cooker. A 6-quart, 15-pound pressure cooker by MIRRO was used to prepare all pressure cooked potatoes. Based on preliminary testing, samples with 1 liter of cooking water were pressure cooked for 5 minutes, and samples with 2 liters of cooking water were pressure cooked for 7 minutes once full pressure was reached. Per the cooking procedure, the cooking water was discarded, and the potatoes were allowed to cool for 5 minutes in a strainer and were then placed into individual plastic bags, hand massaged until potato slices were homogenous, labeled, and stored in a refrigerator at 35°F until further analysis.

Microwave. Once the potatoes were prepared as described above and ready to be cooked, each treatment group was placed into a separate glass bowl. Potatoes in 5 times the amount of cooking water to potatoes were microwaved for 20 minutes. The potatoes in 10 times the amount of cooking water to potatoes were microwaved for 30 minutes. Per the cooking procedure, the samples were handled and stored as previously described.

Boil. Once the potatoes were prepared as described above and ready to be cooked, each group was placed into boiling water in a separate stainless steel pan. All potatoes, regardless of volume of cooking water used, were cooked for about 10-15 minutes until fork tender.

Preparation of Washington State Potatoes

For the following methods, Russet potatoes from the same storage lot were obtained from a commercial processing plant in Quincy, WA. Again, prior to processing, all potatoes were rinsed, peeled, and sliced to a specified thickness. A control potassium value was obtained from 25 raw, untreated potatoes. The average initial potassium value was 542 mg/100 g wet weight (Appendix C, Table C.12).

Ethylenediaminetetraacetic acid (EDTA), citrate, and hot and cold water. Five potatoes were sliced to a 6-mm thickness and then divided randomly into the following groups. Each group had approximately 1 cup (200 g) of potatoes:

EDTA (potatoes were soaked in 2 liters of 0.5% EDTA solution)

0.25%C (potatoes were soaked in 2 liters of 0.25% citrate solution)

0.5%C (potatoes were soaked in 2 liters of 0.5% citrate solution)

1%C (potatoes were soaked in 2 liters of 1% citrate solution)

CW (potatoes were soaked in 2 liters of cold water)

HW (potatoes were soaked in 2 liters of hot water).

All of the groups were allowed to soak for 2 hours in the designated solutions. The soak water and chemical solutions were discarded, and replaced after 1 hour. The potatoes were then placed into separate stainless steel pots with 1 liter of boiling water and allowed to cook on a conventional stove for approximately 10-12 minutes until fork tender. Per the cooking procedure, the cooking water was discarded, and the potatoes were allowed to cool for 5 minutes in a plastic strainer. The potatoes were then handled and stored as previously described.

Agitated. Five potatoes were sliced randomly into three different thicknesses and then divided into the following groups. Each group contained approximately 1 cup (200 g) of potatoes:

4A (4 mm, 2 hour soak, agitated while soaking, cooked in 1 liter of boiling water)

6A (6 mm, 2 hour soak, agitated while soaking, cooked in 1 liter of boiling water)

8A (8 mm, 2 hour soak, agitated while soaking, cooked in 1 liter of boiling water).

Once the potatoes were divided into the three thicknesses, they were placed into three large bowls each containing 2 liters of lukewarm tap water, and allowed to soak for 2 hours. The bowls were placed on magnetic stirring platforms, and a magnetic stir bar was allowed to spin inside each bowl. This allowed for continuous agitation of the potatoes and soaking water. After 1 hour, soaking water was discarded, and replaced with fresh lukewarm tap water. Agitation of the water with the magnetic stir bar was again initiated. The potatoes were then placed into individual stainless steel pots with 1 liter of boiling water and allowed to cook on a conventional stove for approximately 10-12 minutes until fork tender. Per the cooking procedure, the potatoes were handled and stored as previously described.

Tomato Centrifuging Methods

Three varieties of all-natural canned tomato sauce were selected from a local grocery store for processing and analysis: Brand A, Brand B, and Brand C. Thirty grams of each of the three tomato sauces was poured into individual 27 mm X 100 mm plastic centrifuge tubes. Triplicate samples of each brand were collected. Four samples at a time were placed into a Beckman model J-21C centrifuge and allowed to spin at 10,000 RPMs for 15 minutes. The samples were then removed from the machine. The centrifuge process caused the tomato sauce to separate into two layers: a liquid, upper layer referred to as the *supernatant,* and a more dense, lower layer referred to as the *residue*. The supernatant was poured from the centrifuge tube through Whatman No. 541 filter paper and collected into a plastic vial. This was designated as the *filtrate,* and was placed in a refrigerator at 35°F until further analysis.

The residue remaining in the centrifuge tube was reconstituted with the same amount of double distilled water as was poured off after the first centrifuge. After thoroughly mixing, this reconstituted mixture was again placed into the centrifuge machine and run at 10,000 RPMs for 15 minutes. The supernatant was again poured through filter paper into a collecting bottle, and the residue was reconstituted, mixed, and centrifuged for a third and final time. Once again, the supernatant was poured through filter paper and into a collecting bottle. The residue was then removed from the centrifuge tube, placed into a porcelain crucible, and weighed.

Dry Ashing Procedure

Six subsamples of mashed potatoes and triplicate tomato sauce samples were taken from each of the treatments. Mashed potato samples, untreated tomato sauce samples, and tomato sauce residues were all prepared following the procedure described below.

Approximately 5 grams of each sample was weighed into a porcelain crucible. These samples were put into a drying oven at 80°F for 24 hours. A dry weight was recorded, and the dry samples were then placed into a muffle furnace at 500°C for 24 hours. This procedure reduced the samples to ash (see Appendix C, Tables C-2 to C-14 for all raw data).

Dilution Preparations

The following procedure was used to prepare the ashed samples for analysis with the atomic absorption spectrometer.

1. Ashed samples put into solution with 2 ml of 6N HCl.
2. Poured solution from crucible into a glass vial using a funnel to minimize spilling.
3. Rinsed crucibles into collecting vial with 8 ml of double distilled water. (This was done to ensure all material from crucible was transferred to the glass vial)
4. Pipetted 10 ml double distilled water into collecting vial.
5. Resulting final volume of sample was 20 ml.

An aliquot of each solution was diluted such that the potassium values would be within the linear range of detection for the atomic absorption spectrometer. Lanthanum chloride, which is an alkali salt, was used as the final dilution medium to control for ionization during atomic absorption analysis.

Atomic Absorption Analysis

The dilutions were analyzed for their potassium content using a Perkin Elmer 3100 atomic absorption spectrometer (May 1990; Norwalk, Connecticut). Standard atomic absorption conditions for potassium as outlined in the instruction manual were used--wavelength: 766.5 nm, slit: 1.4 nm, sensitivity: 0.043 mg/L, linear range 2.0 mg/L. Four potassium readings were averaged for each sample analyzed.

Inductively Coupled Plasma Analysis

Twenty-four samples were sent to the Utah State University Analytical Laboratory to be analyzed by the inductively coupled plasma (ICP) method. This analysis provides a full spectrum analysis for 22 minerals including potassium.

Sensory Analysis Panel

Sensory data were collected for mashed potato and tomato sauce (first and second centrifuged) samples. Ninety-two dialysis patients and 55 non-patients were given samples of four mashed potato products and two tomato sauce products. From a hedonic scale, 9=Like extremely to 1=dislike extremely, participants were asked to score the products based on flavor, texture, and overall quality (Appendix B.1-B.2). Data were also collected on each participant's likelihood of preparation, frequency of consumption, and overall preference for mashed potatoes and tomato sauce (Appendix B.1-B.3). Information on age, gender, level of education, and length of time on dialysis was also obtained (Appendix B.3).

The dialysis patients sampled and judged the products while they were hooked up to the dialysis equipment. Therefore, in many cases it was necessary for the interviewer to write the ratings on the questionnaires for the patients. Positional bias was blocked by using four versions of the mashed potato questionnaire and two versions of the tomato sauce questionnaire.

Mashed potato samples

Four of the potato cooking methods that were studied were evaluated by sensory analysis. These included:

1. Control (no soak, 4 mm thickness, boiled in 1 liter of water)
2. Pressure cook (4 mm thickness, 2 hour soak, 2 liters of water, cooked for 7 minutes)
3. Microwave (4 mm thickness, 2 hour soak, 2 liters of water, cooked for 30 minutes)
4. Boiled (4 mm thickness, 2 hour soak, 2 liters of water, cooked for 10-12 minutes)

All potato samples were mashed, and for every 500 grams of mashed potato, whipping cream (250 ml) and low sodium butter (14 g) were added prior to being served to the participants. The panelists were given four sampling cups labeled with a three-digit random identification number and approximately 10 grams of mashed potato sample. Prior to being served to panel members, potato samples were heated for 15 seconds in a microwave oven. A cooking instructions methodology sheet was photocopied and given to the patients for use in their own cooking of potatoes at home. (See Appendix B.4.)

Tomato sauce samples

Tomato sauce residues were collected after the first and second centrifuges. Preliminary testing determined that vinegar and spices were needed for reconstitution of the residue samples. Three hundred grams of residue from each method (first and second centrifuge) were reconstituted with water. The second centrifuge was more bland and required the addition of vinegar and a slightly different amount of spices. (See Table 1.)

Table 1
Tomato sauce recipe for reconstitution of tomato sauce residues

Ingredient	First Centrifuge	Second Centrifuge
Italian Seasoning	1 t.	1 t.
Garlic Powder	½ t.	1 t.
Onion flakes	¼ t.	¾ t.
Vinegar		1 t.
Water	1 cup	1 ¼ cups
K (mg/g)	1.41mg	0.34mg

(See Appendix A for calculation of potassium [mg/g].)

The new mixture of residue, water, spices, and vinegar (second centrifuge) was heated on a conventional stove over medium heat for about 20 minutes. Two teaspoons of sauce were spread on toasted English muffins and served with cheese sprinkled on top. Prior to being served to the panel members, English muffin pizzas were placed in a microwave oven for 15 seconds to melt the cheese. The muffins were cut into four sections and each participant received one section.

Statistical Analysis

SPSS Release 4.1 for VAX/VMS was used to run all statistical procedures. A multiple analysis of variance (MANOVA) was used to evaluate the main effects and interaction of the potato cooking methods, potato slice thickness, and volume of cooking water. The least significant difference (LSD) procedure was used to detect the source of differences between the cooking methods, slice thickness, and volume of cooking water. An analysis of variance (ANOVA) was used to test differences within the top 10 potassium leaching methods, differences between methods of tomato sauce preparation, brand of tomato sauce, and differences among the flavor, texture, and overall quality scores for sensory evaluation data.

RESULTS AND DISCUSSION

Logan, Utah Potatoes

A significant difference ($P<0.05$) was found between the three main effects and the three-way interaction of cooking method, potato slice thickness, and cooking water volume (Appendix D, Table D.1). Potassium loss was increased when a thinner sliced potato was used ($P<0.05$). Independent of slice thickness or cooking method, there was also a significant difference ($P<0.05$) in potassium loss when a greater water-to-potato ratio was used. The potatoes cooked in 2 liters of water (124 mg per 100 g wet weight; water-to-potato ratio of 10:1) lost more potassium than those cooked in 1 liter of water (148 mg per 100 g wet weight; water-to-potato ratio of 5:1; $P<0.05$; Appendix D).

Figures 1-6 graphically display the percentages of potassium lost when the potatoes were prepared by the various methods. When potatoes were boiled (Figure 1), there was an increased percentage of potassium lost with the thinner sliced potatoes, those boiled in a water-to-potato ratio of 10:1, and those that were soaked for 24 hours. In all cases, the potatoes that were boiled in a water-to-potato ratio of 10:1 lost more potassium than those boiled in a water-to-potato ratio of 5:1. As much as 80% (76.18 mg/100 g) of the original potassium could be leached from these potatoes as a result of 4-mm thickness/24-hour soak and a water-to-potato ratio of 10:1. This method, however, is very time consuming and is not likely to be followed by the dialysis patient. Alternatively, the potatoes prepared by the 4-mm thickness/no soak and a water-to-potato ratio of 10:1 method do not require extensive preparation time and lost 78% (81.86 mg/100 g) of the original potassium.

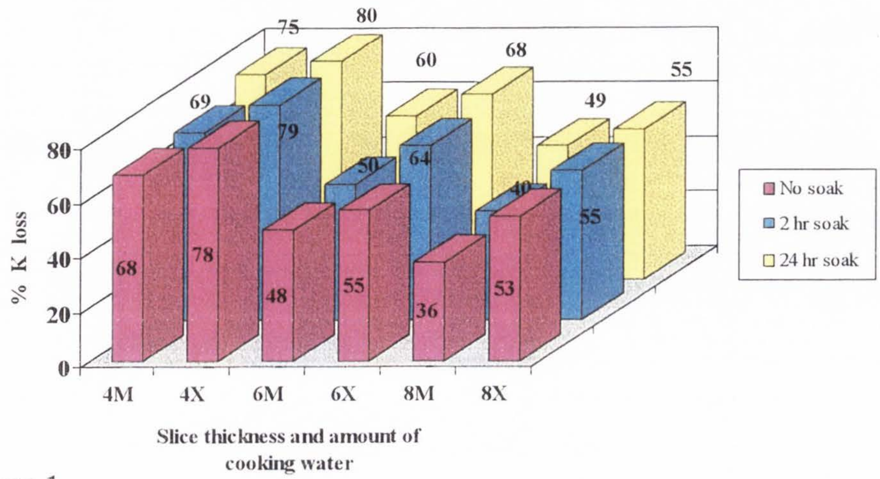


Figure 1
Potassium loss in boiled potatoes according to slice thickness, water volume, and soak time
M=1 liter of cooking water. X=2 liters of cooking water. 4=4 mm, 6=6 mm, 8=8 mm.

Figure 2 shows potassium loss in potatoes that were prepared using a microwave. Again, the same trends as seen in the boiled potatoes are also seen here. As the potatoes were sliced thinner and cooked in a greater water-to-potato ratio, they usually lost more potassium.

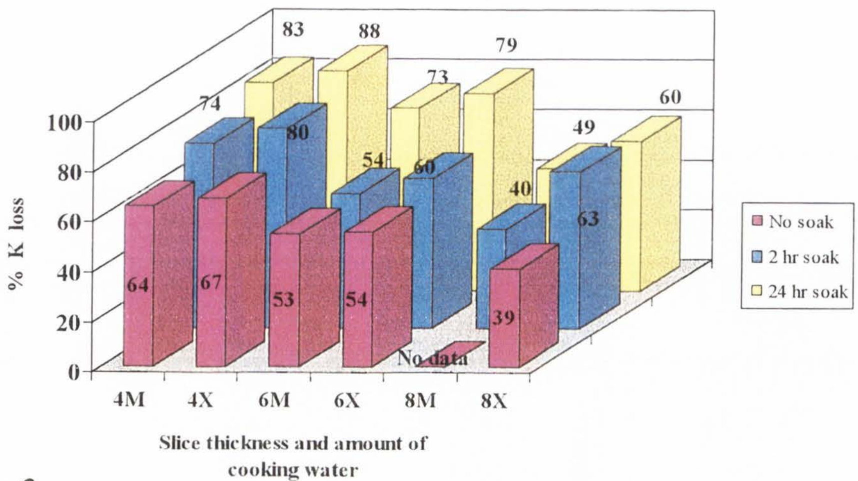


Figure 2
Potassium loss in microwaved potatoes according to slice thickness, water volume, and soak time
M=1 liter of cooking water. X=2 liters of cooking water. 4=4 mm, 6=6 mm, 8=8 mm.

Figure 3 illustrates the results from the potatoes that were prepared using the pressure cooker. When potatoes were sliced to 4-mm thickness, soaked for 24 hours, and pressure cooked in a water-to-potato ratio of 10:1, they lost as much as 92% (28.94 mg/100 g) of their original potassium. This decrease in potassium content is significantly different from all other methods studied ($P<0.05$). However, because of the preparation time involved, this method is not likely to be followed by the dialysis patient. The method in which the potatoes were prepared by 4-mm thickness/no soak, pressure cooked in a water-to-potato ratio of 10:1 reduced the potassium content by 77% (88.25 mg/100 g), and is more likely to be incorporated by dialysis patients.

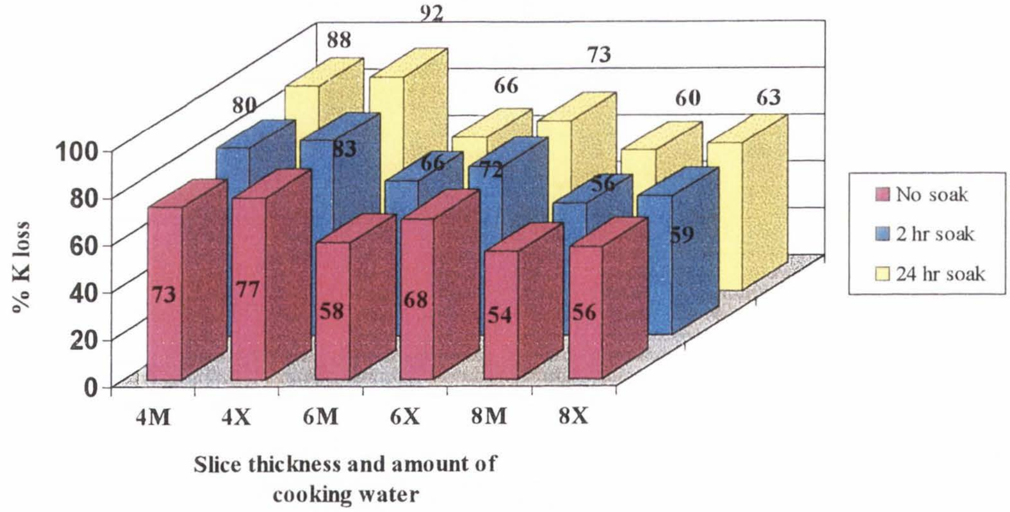


Figure 3
Potassium loss in pressure cooked potatoes according to slice thickness, water volume, and soak time
M=1 liter of cooking water, X=2 liters of cooking water. 4=4 mm, 6=6 mm, 8=8 mm.

Figure 4 shows the percentage of potassium lost when the potatoes were prepared by the three methods without a soaking period. In most cases, the pressure cook method resulted in a greater loss of potassium.

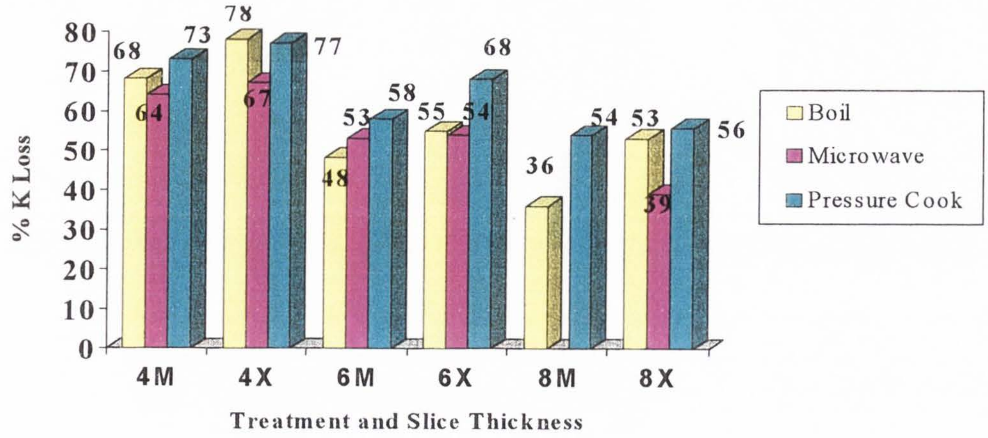


Figure 4
Comparison of potassium loss in potatoes for methods without a soak period according to slice thickness and water volume
M=1 liter of cooking water, X=2 liters of cooking water. 4=4 mm, 6=6 mm, 8=8 mm.

Figures 5 and 6 again show the trends already described from Figures 1-4, namely, that as slice thickness decreases and water to potato cooking ratio increases, the percentage of potassium lost increases.

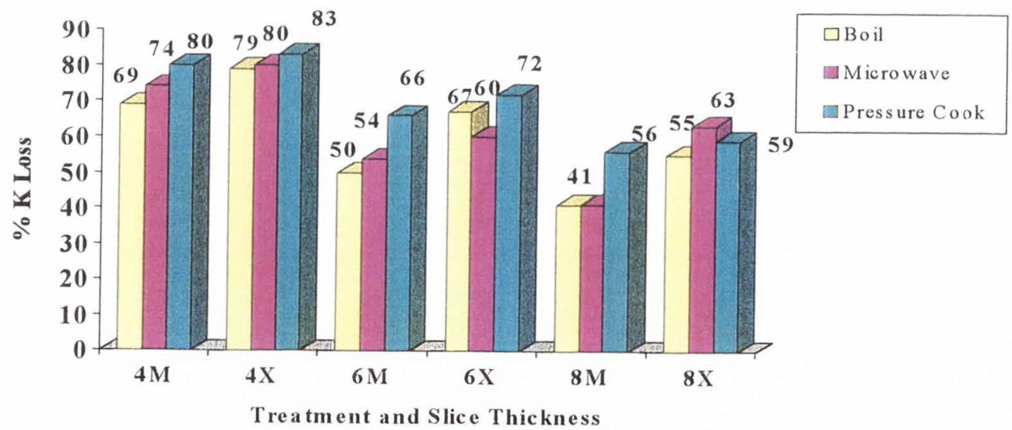


Figure 5
Comparison of potassium loss in potatoes for methods with a 2-hour soak according to slice thickness and water volume
M=1 liter of cooking water, X=2 liters of cooking water. 4=4 mm, 6=6 mm, 8=8 mm.

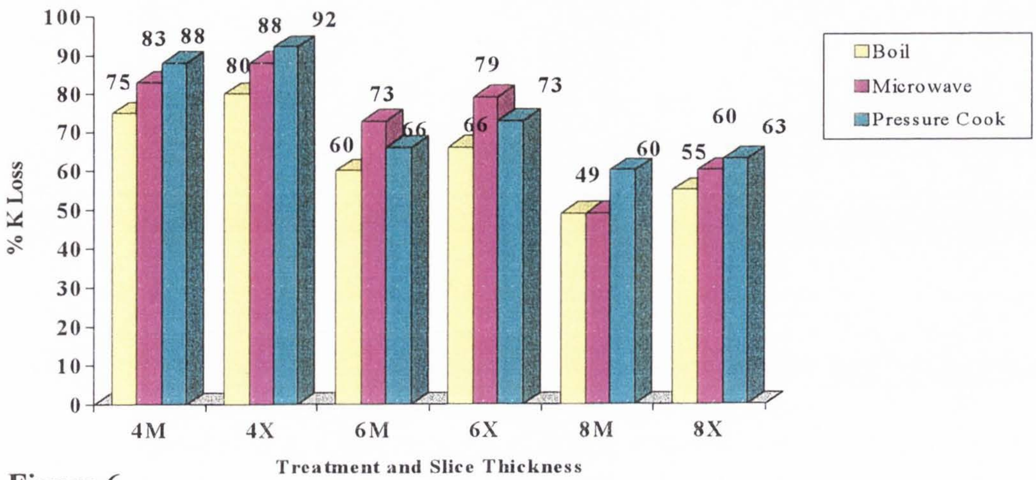


Figure 6
Comparison of potassium loss in potatoes for methods with a 24-hour soak according to slice thickness and water volume
M=1 liter of cooking water, X=2 liters of cooking water. 4=4 mm, 6=6 mm, 8=8 mm.

Table 2 lists the 10 most effective methods for reducing the potassium content, the average potassium values, and the percentage of potassium lost from each method. The first method listed on Table 2, pressure cook/24-hour soak/4-mm/2 liters of water, yielded a mean potassium value of 28.94 mg per 100 g wet weight, which was a reduction of 92% of the original potassium. This was determined to be the most effective method in leaching potassium ($P<0.01$; Appendix D, Table D.5). The microwave/24-hour/4-mm/2 liters (46.27 mg/100 g) method and the pressure cook/24-hour/4-mm/1 liter (46.65 mg/100 g) method were not statistically significant from one another. However, they were statistically different from the rest of the methods.

Table 3 lists the inductively coupled plasma (ICP) analysis for the 10 most effective preparation methods. Regardless of cooking method, the percentages of nutrients lost through cooking were fairly consistent within each nutrient category.

Table 2
Ten most effective methods for leaching potassium from potatoes

Treatment	Soak	Thickness	Volume H_2O	Mean K (mg/100g)	% K lost
Pressure Cook	24 hour	4 mm	2 liters	28.94^{a}	92%
Microwave	24 hr	4 mm	2 liters	46.27^{b}	88%
Pressure Cook	24 hr	4 mm	1 liter	46.65^{b}	88%
Microwave	24 hr	4 mm	1 liter	63.58^{c}	83%
Pressure Cook	2 hr	4 mm	2 liters	66.22^{c}	83%
Pressure Cook	2 hr	4 mm	1 liter	74.90^{c}	80%
Boil	24 hr	4 mm	2 liters	76.18^{c}	80%
Microwave	2 hr	4 mm	2 liters	$77.50^{c,d}$	80%
Boil	2 hr	4 mm	2 liters	80.65^{d}	79%
Boil	No soak	4 mm	2 liters	81.86^{d}	78%

Percentages based on 380 mg/100 g control potato potassium values
Means with the same letter are not significantly different $(P<0.05)$
(Appendix D)

Table 3
Inductively coupled plasma (ICP) analysis of nutrient losses from the10 most effective cooking methods

Treatment	K	Cu	Fe	Mg	P	Zn	Na
PC/24/4mm/2liters	93%	39%	10%	67%	44%	39%	46%
MW/24/4mm/2liters	82%	36%	48%	66%	51%	57%	83%
PC/24/4mm/1liter	87%	42%	38%	52%	30%	52%	83%
MW/24/4mm/1liter	81%	64%	36%	64%	49%	58%	82%
PC/2/4mm/2liters	79%	36%	48%	62%	42%	59%	80%
PC/2/4mm/1liter	80%	53%	51%	66%	43%	63%	79%
Boil/24/4mm/2liters	82%	61%	11%	63%	43%	62%	89%
MW/2/4mm/2liters	81%	58%	38%	64%	44%	58%	90%
Boil/2/4mm/2liters	83%	31%	41%	66%	42%	16%	54%
PC/NS/4mm/2liters	80%	64%	16%	65%	33%	52%	79%

Expressed as percent loss
PC=Pressure cook, MW=Microwave, 24=24-hour soak, 2=2-hour soak, NS=no soak

These results are significant because they suggest that potassium and sodium, which both had an average loss of 83%, are less stable minerals and appear to be more vulnerable to leaching, whereas the other nutrients analyzed were retained in the potato samples in greater percentages.

Washington State Potatoes

Figure 7 illustrates the potassium loss among the Washington state potatoes as a result of the addition of EDTA, various concentrations of citrate to the soak water, continuous agitation of soak water, and hot versus cold temperature soak water. From the graph one can see that the potassium losses among these potatoes were similar to the Logan, Utah potatoes that were prepared under similar conditions, i.e., boiled/6-mm thickness/2-hour soak/cooked in water-to-potato ratio of 10:1 (50% potassium loss). The adddition of chelators, agitation of soak water, and soaking potatoes in cold versus hot water do not appear to be more effective than previously studied methods in reducing potassium.

Tomato Sauce Samples

Figure 8 shows the overall trend and changes that occurred with each successive centrifuge process of tomato sauce. The value 3.65 mg/g of sauce is the average of the three tomato sauce brands. The first centrifuge process reduced the potassium to 2.54 mg/g of residue. Prior to consumption, the residue was reconstituted with 1 cup of water; hence, due to the dilution of the water, the potassium was ultimately reduced in the first centrifuge process to 1.41 mg/g of reconstituted sauce

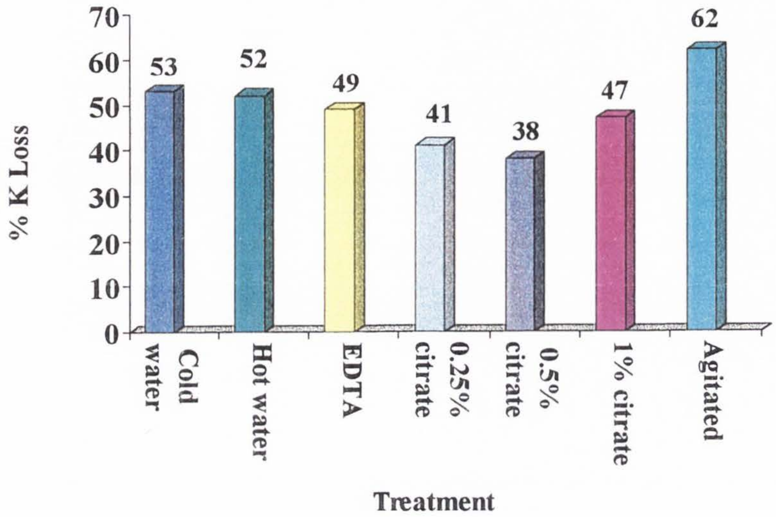


Figure 7

Percent potassium loss as a result of the addition of chemical chelators, hot versus cold soak water, and continuous agitation of soak water

All potatoes were sliced to 6-mm slice thickness, soaked for 2- hours, and boiled in 2 liters of water.

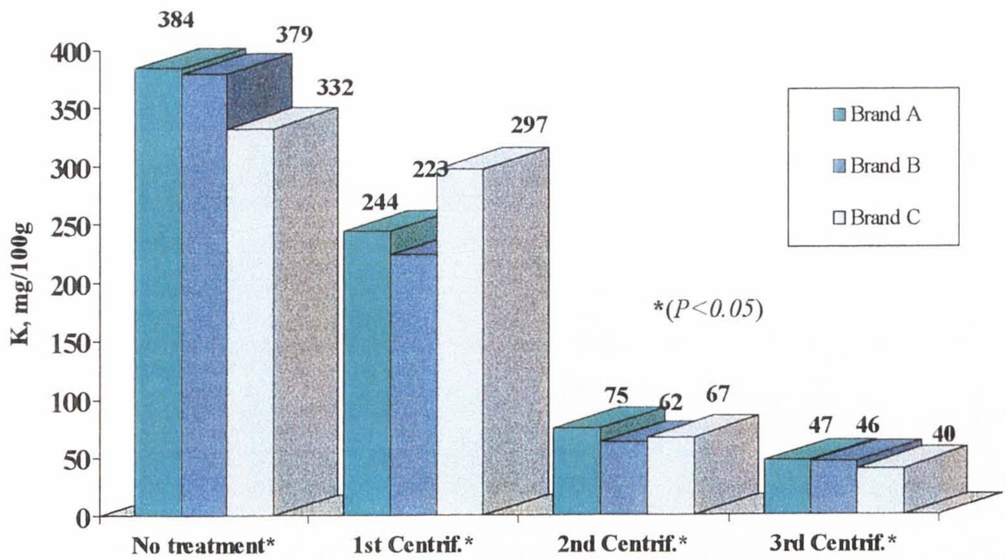


Figure 8

Potassium values of tomato sauce residues as a result of centrifugation (see Appendix A.1 for calculations). Based on a ½ cup serving, this amounts to a 61% reduction in potassium. A second centrifuge process reduced the potassium content further, to 0.68 mg/g of residue or 0.34 mg/g of reconstituted sauce, a 91% reduction in the original potassium content. A third and final centrifuge process reduced the potassium to 0.16 mg/g of reconstituted sauce. This amounted to a 96% reduction in the original potassium content. The potassium levels were significantly different ($P<0.05$) between the treatments, but differences between brands were not found to be significant ($P=0.747$; Appendix D, Table D.7).

The original tomato sauce and the third centrifuge tomato sauces were also evaluated for their sodium content. Figure 9 illustrates the effects of a third centrifuge on the sodium content of tomato sauce. The original sauce had an average sodium value of 391 mg/100g. This was reduced significantly after the third centrifuge by 95% to an average sodium value of 21 mg/100 g ($P<0.05$; Appendix D, Table D.8). Brand B (untreated: 303.6 mg/100 g) and brand C (untreated: 6.5 mg/100 g) started with less, and lost more sodium (third centrifuge: 12.5 mg/100 g, 0 mg/100 g, respectively) than brand A (untreated: 479.4 mg/100 g, after third centrifuge: 28 mg/100 g).

Sensory Analysis

Ninety-two patients and 55 non-patients (family and staff) from three different dialysis clinics (Bonneville Dialysis, Kolff Renal, and Central Valley Dialysis) were recruited for sensory analysis of the mashed potato and tomato sauce samples. Seventy-eight of the patients were female and 69 were male with the average age ranging between 46-55 years and length of time on dialysis between 4-6 years.

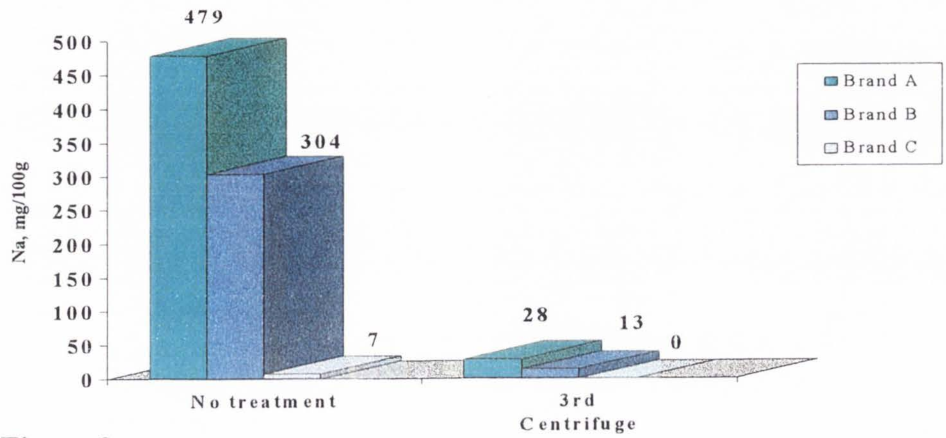


Figure 9
Sodium values of tomato sauce residues as a result of centrifugation

The participants were asked how often they eat mashed potatoes and how much they like mashed potatoes in general. From those surveyed, 64% of the individuals prepare potatoes one or more times each week, and 82% stated that they liked potatoes very much. The results of the average ratings for the three characteristics of the mashed potatoes are listed in Table 4. Taste preferences as indicated by scores for flavor, texture, and overall quality were not related to method used to prepare potatoes ($P<0.05$). The differences among potassium content for the various methods used for sensory analysis were: microwave -- 77.5 mg/100 g (80% potassium loss), pressure cooker -- 66.22 mg/100 g (83% potassium loss), boil -- 80.65 mg/100 g (79% potassium loss), and control -- 122.5 mg/100 g (69% potassium loss). After the patients had sampled and rated the potatoes, they were asked on the follow-up survey questionnaire (Appendix B.3) whether or not they would prepare the potatoes knowing that they were low in potassium.

Table 4
Average hedonic ratings for mashed potatoes

Treatment	Flavor	Texture	Overall Quality	Would you prepare?	
Microwave	6.5[a]	6.7[a]	6.6[a]	87%-Yes	12%-No
Pressure cooker	6.7[a]	6.8[a]	6.8[a]	90%-Yes	9%-No
Boil (2 L H_2O)	6.8[a]	6.9[a]	6.8[a]	88%-Yes	10%-No
Control (1 L H_2O)	6.7[a]	6.9[a]	6.8[a]	86%-Yes	11%-No

9=Like extremely, 8=Like very much, 7=Like moderately, 6=Like slightly, 5=Neither like nor dislike, 4=Dislike slightly, 3=Dislike moderately, 2=Dislike very much, 1=Dislike extremely
n=147
Mean scores with the same letter are not significantly different at $P<0.01$

Figure 10 illustrates the percentage of participants who scored the overall quality of potatoes $\geq$ 7 (like moderately). Figure 10 also points out that a large percentage of participants indicated that they would prepare the potatoes, regardless of the method used. Finally, there was no taste preference difference for the flavor, texture, and overall quality of the potato products as evaluated between the patients and non-patients, males and females, and the different age categories (Appendix D, Tables D.9-D.17).

The participants were also asked how often they use tomato sauce and how much they like tomato sauce in general. These results indicated that 79% of the individuals use tomato sauce one or more times per week, and 61% of them stated that they like tomato sauce very much. Table 5 shows the average scores for the different characteristics of the two tomato sauces sampled. The first centrifuge tomato sauce was preferred by the participants in this study as indicated by ratings for flavor, texture, and overall quality ($P<0.05$; Appendix D, Tables D.18-D.26). Nevertheless, when asked whether or not they would buy the product if it was available in the grocery store, 88% (first centrifuge) and

83% (second centrifuge) of those sampled indicated that they would purchase the low potassium tomato sauce (see Figure 11). In fact, many of the dialysis patients expressed an immediate desire and interest to purchase the tomato sauce. No taste preference difference was found for the flavor, texture, and overall quality of the tomato sauce products as evaluated between patients versus non-patients, males versus females, and between the different age categories.

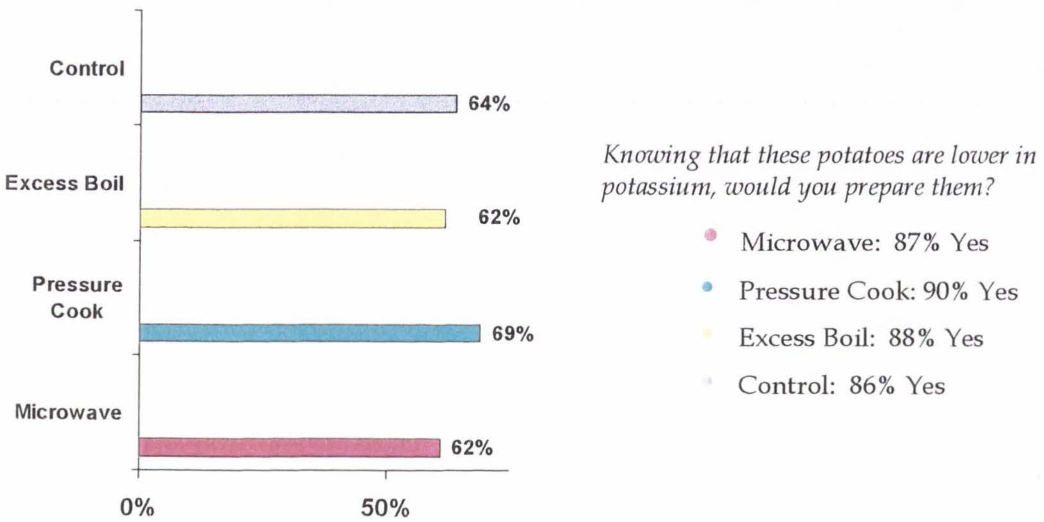


Figure 10
Percentage of panelists who scored the overall quality of mashed potatoes ≥ 7*

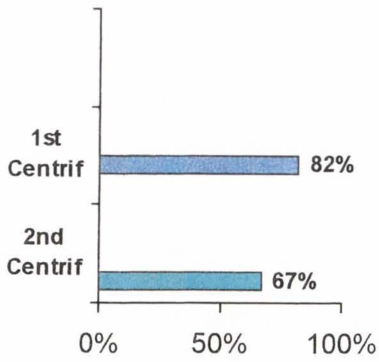
*1=Dislike extremely, 2=Dislike very much, 3=Dislike moderately, 4=Dislike slightly, 5=Neither like nor dislike, 6=Like slightly, 7=Like moderately, 8=Like very much, 9=Like extremely.

Table 5
Average hedonic ratings for tomato sauce

Treatment	Flavor	Texture	Overall Quality	Would you prepare?	
1^{st} Centrifuge	7.2^a	7.2^a	7.3^a	88%-Yes	10%-No
2^{nd} Centrifuge	6.6^b	6.9^b	6.7^b	83%-Yes	13%-No

9=Like extremely, 8=Like very much, 7=Like moderately, 6=Like slightly, 5=Neither like nor dislike, 4=Dislike slightly, 3=Dislike moderately, 2=Dislike very much, 1=Dislike extremely
n=147
Mean scores with the same letter are not significantly different at $P<0.01$

As mentioned in the methods section, it was necessary to add a different amount of spices and vinegar to the second centrifuged tomato sauce. This creates a confounding factor to keep in mind when interpreting the tomato sauce sensory analysis data. Figure 11 illustrates that overall, 82% of the participants rated the first centrifuged sauce with an overall quality rating of≥7 (like moderately), and 67% rated the second centrifuged sauce with an overall quality of≥7.



Knowing that these tomato sauces are lower in potassium, would you purchase them?

- 1st Centrifuge: 88% Yes
- 2nd Centrifuge: 83% Yes

Figure 11
Percentage of panelists who scored the overall quality of tomato sauce ≥ 7*
*1=Dislike extremely, 2=Dislike very much, 3=Dislike moderately, 4=Dislike slightly, 5=Neither like nor dislike, 6=Like slightly, 7=Like moderately, 8=Like very much, 9=Like extremely.

CONCLUSIONS

Due to the complicated nature of dietary compliance and the tendency for many dialysis patients to be noncompliant with nutritional protocols, dietitians and health professionals working with these individuals have a very important responsibility. It becomes critical for these health care providers working with ESRD patients to become familiar with and provide simple and quick cooking alternatives for the preparation of foods that are limited or omitted from the diet.

Through this study, results from previous research experiments were confirmed, which indicate that slice thickness, volume of water, and a soaking period all affect potassium content, i.e., the thinner the slice or the greater the surface area, the greater the nutrient losses; the more water that is used, the greater the cooking losses; and finally, a longer soaking period in most instances will result in greater nutrient losses.

This study found that pressure cooking, microwaving, or boiling thinly sliced potatoes in a water-to-potato ratio of 10:1 cannot only be quick and simple but also very effective in reducing the potassium content from potatoes. By using a pressure cooker, thinly sliced potatoes and a water-to-potato ratio of 10:1, individuals can prepare potatoes in less than 15 minutes that have a 77% reduction in potassium content. Potassium loss can be increased to 83% with a 2-hour soak and to 92% if patients are willing to soak the potatoes for 24 hours. Sensory evaluation indicated that 90% of those questioned liked the pressure-cooked potatoes well enough to try this method at home. Eighty-seven percent of those surveyed indicated that they would prepare the microwaved potatoes, which require a longer cooking time but were found in a no soak to have a 67%

potassium loss. An 80% loss was obtained from a 2-hour soak, and an 88% potassium loss resulted after a 24-hour soak. Boiling was also found to significantly reduce potassium levels. A no soak of thinly sliced potatoes and boiled in a water-to-potato ratio of 10:1 resulted in a 78% potassium loss. A 2-hour soak reduced the potassium by 79%, and a 24-hour soak ended with an 80% reduction in potassium.

In this study it was also found that other nutrient losses such as copper, iron, magnesium, phosphorous, and zinc are not as susceptible as the electrolytes, potassium, and sodium to being leached from potatoes as a result of different processing methods. Potassium and sodium are very vulnerable to the cooking methods and are leached out in greater amounts.

The addition of the chemical chelators EDTA and various concentrations of citrate to the soaking water were not found to be more effective in leaching potassium than a soaking period without the chelators. Similarly, agitation of the soak water or the use of hot versus cold water for soaking was not more effective than a regular soak period.

The tomato sauce data indicate that centrifugation of tomato sauce can indeed reduce the potassium value by as much as 96% and the sodium level by as much as 95%. Although this too is a quick and easy process, the necessary equipment is very expensive and unrealistic for patients to purchase. Perhaps with this method, however, a processor such as Hunts or Del Monte would find an interest and incorporate it into their production line for commercial availability. Certainly among the dialysis population, there is a great need to have available to them more palatable and inexpensive specialty foods such as the low-potassium tomato sauce developed.

REFERENCES

1. Doran P. *United States Renal Data System 1996 Annual Data Report, National Institute of Diabetes and Digestive and Kidney Diseases*, NIH, HHS, 1996. (http://www.med.umich.edu/usrds/)

2. Mahan KL, Arlin MT. *Krause's Food, Nutrition and Diet Therapy* 8th ed. Philadelphia, Penn: W.B. Saunders Company; 1992.

3. Zeman FK. *Clinical Nutrition and Dietetics*, New York: Macmillan Publishing Company; 1991.

4. Eddins BR. Chronic self-destructiveness as manifested by non-compliant behavior in hemodialysis patients. *J Nephrol Nurs* 1985; July/Aug: 194-198.

5. Abram HS, Moore GL, Westervelt FB. Suicidal behavior in chronic dialysis patients. Am *J Psychiat* 1971; 127:1199-1205.

6. Wolcott DL, Maida CA, Diamond R. Treatment compliance in end-stage renal disease patients on dialysis. *Am J Nephrol* 1986; 6:329-338.

7. Manley M, Sweeney J. Assessment of compliance in hemo-dialysis adaptation. *J Psychosom Res* 1986; 30:153-161.

8. Ferraro KF, Dixon RD, Kinlaw BJR. Measuring compliance among in-center hemo-dialysis patients. *Dial Transplant* 1986; 15:226-236.

9. Cummings KM, Becker MH, Kirscht JP. Psychosocial factors affecting adherence to medical regimens in a group of hemo-dialysis patients. *Medcare* 1982; 20:567-580.

10. Hoover H. Compliance in hemo-dialysis patients. A review of the literature. *J Am Diet Assoc* 1989; 89:957-959.

11. DeNour AK, Czackes JW. Personal factors in chronic hemo-dialysis patients noncompliance with medical regimen. *Psychosom Med* 1972; 34:333-344.

12. Watt BK, Merrill AL. *Composition of Foods, Raw, Processed and Prepared.* USDA Handbook No. 8, 1989.

13. Block G, Dresser CM, Hartman AM, Carroll MD. Nutrient sources in the American diet: Quantitative data from the NHANES II Survey. I. Vitamins and Minerals. *Am J Epidem* 1985; 122:13-26.

14. Woodward CF, Talley EA. Review of the nitrogenous constituents of the potato. Nutritive value of the essential amino acids. *Am Potato J* 1953; 30: 205.

15. Mondy NI, Munshi CB. Effect of type of potassium fertilizer on enzymatic discoloration and phenolic, ascorbic acid, and lipid contents of potatoes. *J Agric and Food Chemistry* 1993; 41:849-852.

16. Augustin J. Variations in nutritional composition of fresh potatoes. *J Food Science* 1975; 40:1295-1298.

17. Chapman KS, Sparrow LA, Hardman PR, Wright DN, Thorp JR. Potassium nutrition of Kennebec and Russet Burbank Potatoes in Tasmania: Effect of soil and fertilizer potassium on yield, petiole and tuber potassium concentrations, and tuber quality. *Australian J Exper Agriculture* 1992; 32:521-530.

18. Mondy NI, Ponnampalam R. Effect of baking and frying on the nutritive value of potatoes. I. Minerals. *J Food Science* 1983; 48:1475-1480.

19. Macklon AE, Deckock PC. Physiological gradients in the potato tuber. *Physiol Plantatum* 1967; 20:421-425.

20. Johnston FB, Kenkars E, Nunes AC. Starch and dry matter content of netted gem in relation to french fry texture. *Am Potato J* 1970; 47:87-94.

21. Klein LB, Mondy NI. Comparison of microwave and conventional baking of potatoes in relation to nitrogen constituents and mineral composition. *J Food Science* 1981; 46:1874-1877.

22. Denton MC. Changes in food value of vegetables due to cooking. *J Home Econ* 1919; 11:143-209.

23. Berry JT. Losses in the cooking of vegetables. *J Home Econ* 1912; 4:405-412.

24. Dansfors S, Bruce A. Changes in potassium and sodium contents of potatoes cooked by various methods. *Var Foda* 1984, 36:448. (Abstract).

25. Henningsen NC, Larson L, Nelson D. Hypertension, potassium and the kitchen. *Lancet.* 1983; 1(8316):133-135.

26. Eshtiaghi MN, Knorr D. Potato cubes response to water blanching and high hydrostatic pressure. *J Food Science*. 1993; 58:1371-1378.

27. Harris RS, Karman E (eds). *Nutritional Evaluation of Food Processing.* 2nd ed. Westport, Conn.: AVI Publishing; 1975.

28. Gekas V, Oste R, Lamberg I. Diffusion in heated potato tissues. *J Food Science* 1993; 58:827-832.

29. Hewston EM, Dawson EH, Alexander LM. Vitamin and mineral content of certain foods as affected by home preparation. *USDA Misc. Publ. #628*, January 1948.

30. Mueller HR. The effect of industrial handling on micronutrition. *J Nutr Sci Vitaminol* 1990; 36:S47-S55.

31. Morgan P. A Report on the vitamin and mineral losses that occur during the boiling of vegetables. *Office of Experiment Station Bulletin #42,* 1897:1-8.

32. Weaver ML, Timm H, Hawkins N. Changes in nutritional composition of Russet Burbank potatoes by different processing techniques. *Am Potato J* 1983; 60:735-744.

33. Tsaltas TT. Dietetic management of uremic patients. *Am J Clin Nutr* 1969; 22:490-493.

34. Peterson WH, Hoppert CA. The loss of minerals and other constituents from vegetables by various methods of cooking. *J Home Econ* 1925; 10:265-280.

35. Kimura M, Itokawa Y. Cooking losses of minerals in foods and its nutritional significance. *J Nutr Sci Vitamin* 1990; 36:S25-S33.

36. Hart JR. EDTA-type chelating agents in everyday consumer products: some medicinal and personal care products. *J Chem Educ* 1984; 61:1060-1061.

APPENDICES

APPENDIX A

Tomato Sauce Calculations and Recipes

Tomato Sauce Calculations

Brand A = Hunts regular tomato sauce
Brand B = Fred Meyer regular tomato sauce
Brand C = Hunts not salt tomato sauce
(1/2 cup regular sauce=122g*3.65mg K/g=445mgK per ½ cup.)

1st Centrifuge
Residue: 298.82 grams
Water: 1 cup (237 grams)
Avg. K=254.4 grams/100g residue
2.54mg/g*298.82g=759mg K/535.82g= **1.41mg K/gram of reconstituted sauce**
(1/2 cup sauce=172 mg K)

2nd Centrifuge
Residue: 290.94 grams
Water: $1^1/_4$ cups (296.25grams)
Avg. K=68g/100g residue
0.68mg/g*290.94g=197.84mg K/587.19g= **0.34mg K/gram of reconstituted sauce**
(1/2 cup sauce=41 mg K)

3rd Centrifuge
Residue: 196.995grams
Water: $1^1/_2$ cups (355.5grams)
Avg. K=44.2g/100g residue
0.442mg/g*196.995g=87.07mg K/552.495g= **0.16mg K/gram of reconstituted sauce**
(1/2 cup sauce=20 mg K)

APPENDIX B

Sensory Analysis Questionnaires

Appendix B.1

Name ______________________________ Time:_______

Tomato Sauce

Please evaluate the samples in the order listed. Choose the response for flavor, texture, and overall quality from the following nine point scale which best expresses your feeling about each characteristic of the product. We would also appreciate your comments on anything you liked or disliked about the samples.

9 = Like extremely
8 = Like very much
7 = Like moderately
6 = Like slightly
5 = Neither like nor dislike
4 = Dislike slightly
3 = Dislike moderately
2 = Dislike very much
1 = Dislike extremely

Put the appropriate number (from above scale) in each box below.

Sample Number	Flavor	Texture	Overall Quality	If you knew this sample had a low potassium content, would you prepare it?
107				
505				

Do you currently eat foods that use tomato sauce?
_____ rarely or never
_____ 4-11 times/year
_____ 1-3 times/month
_____ 1-3 times/week
_____ 4 or more times/week

If your answer is rarely or never, please tell us why.

How much do you like tomato sauce in general ?
______ like very much
______ like moderately
______ like slightly
______ dislike

Age ____ 16-25 ____ 26-35 ____ 36-45 ____ 46-55 ____ 56-65 ____ 66-75 ____ 76-85 ____ 86 or older

Gender ____ male ____ female

Appendix B.2

Name ______________________ Time:______

Mashed Potato Panel

Please evaluate the samples in the order listed. Choose the response for flavor, texture, and overall quality from the following nine point scale which best expresses your feeling about each characteristic of the product. We would also appreciate your comments on anything you liked or disliked about the samples.

9 = Like extremely
8 = Like very much
7 = Like moderately
6 = Like slightly
5 = Neither like nor dislike
4 = Dislike slightly
3 = Dislike moderately
2 = Dislike very much
1 = Dislike extremely

Put the appropriate number (from above scale) in each box below.

Sample Number	Flavor	Texture	Overall Quality	If you knew this sample had a low potassium content, would you prepare it?
251				
923				
660				
141				

Do you currently eat potatoes?
_____ rarely or never
_____ 4-11 times/year
_____ 1-3 times/month
_____ 1-3 times/week
_____ 4 or more times/week

If your answer is rarely or never, please tell us why.

How much do you like mashed potatoes in general ?
______ like very much
______ like moderately
______ like slightly
______ dislike

Age ____ 16-25 ____ 46-55 ____ 76-85
____ 26-35 ____ 56-65 ____ 86 or older
____ 36-45 ____ 66-75

Gender ____ male ____ female

Appendix B.3

Name ______________________________

Follow-up Survey

You have just completed a taste panel in which the mashed potatoes were prepared four different ways as listed below. You rated the products with an **Overall Quality** score as indicated:

Mashed Potatoes	Overall Quality score
660 - control	_____
923 - pressure cooker	_____
141 - microwave	_____
251 - boiled in excess water	_____

Please use the following scale and put the appropriate number which best describes your feelings. We would like to get a better idea of how likely patients are to incorporate these methods into their cooking techniques at home. With the understanding that you would be instructed in any or all of the above techniques, please also take into consideration the appliances you have at home, the amount of time required to prepare the product and your personal preferences when evaluating how likely you would be to prepare this mashed potato product at home.

Likelihood of Preparation Scale

1 definitely would prepare
2 probably would prepare
3 might prepare
4 probably would not prepare
5 definitely would not prepare

Sample	Likelihood of preparation	*Please explain your reasoning for your rating*
660 - control		
923 - pressure cooker		
141 - microwave		
251 - boiled in excess amount of water		

Please indicate your present status:

Patient _____
Staff _____
Family member _____

If you are a patient, how long have you been on dialysis?
___ 1-3 years ___ 7-9 years ___ 13-15 years
___ 4-6 years ___ 10-12 years ___ 16 years or greater

Please indicate the highest level of education completed

_____ Some High School
_____ High School Diploma
_____ Some College
_____ College Degree
_____ Graduate degree

Appendix B.4

Methodology for Potato Sample Preparation

Control potatoes

1. Rinse and peel potatoes
2. Slice to 4mm thickness with a food slicer
3. Place in medium sized sauce pan with just enough water to cover potatoes
4. Boil until fork tender

Pressure cooker

1. Rinse and peel potatoes
2. Slice to 4mm thickness
3. Place potatoes in a large bowl in an excess of water (10 cups) and allow to soak for 2 hours. Change soak water after 1 hour
4. Place in pressure cooker with 2 liters of water
5. Cook on high until pressure knob starts to shake
6. Allow to cook for 5 minutes after the pressure knob starts to shake

Microwave

1. Rinse and peel potatoes
2. Slice to 4mm thickness
3. Place potatoes in a large bowl in an excess of water (10 cups) and allow to soak for 2 hours. Change soak water after 1 hour.
4. Place in fresh bowl of water (2 liters) of water and allow to cook in microwave for 30 minutes or until fork tender. (Time may vary depending upon the power of microwave)

Boiled

1. Rinse and peel potatoes
2. Slice to 4mm thickness
3. Place in a large bowl with an excess of water (10 cups) of water and allow to soak for 2 hours. Change soak water after 1 hour.
4. Place in a sauce pan that has 2 liters of boiling water
5. Allow to cook for about 10-12 minutes or until fork tender.

Heavy whipping cream and low salt butter were added to all of the samples for flavoring

APPENDIX C

Complete Potato and Tomato Sauce Data

Table C.1
Logan, Utah raw potatoes

Sample	Cruc. wt.	Wet wt.	Cruc. + Dry wt.	Dry Wt.	Cruc. + Ash wt.	Ash wt.	K(mg)	K(mg)	K(mg) /20ml	K(mg)/ L	K(mg) /100g Dry Wt.	K(mg) /100g Wet Wt.
DC7	25.57	6.67	26.91	1.35	25.62	0.05	1.2	1.17	29.57	1478	2198	443.3
A134	15.73	6.05	17	1.27	15.78	0.05	0.97	0.98	24.33	1216	1917	402
100	18.23	6.13	19.51	1.29	18.28	0.06	0.95	0.95	23.7	1185	1845	386.5
132A	22.01	6.47	23.27	1.25	22.08	0.06	1.06	1.05	26.32	1316	2099	406.8
CH85	16.28	6.38	17.59	1.31	16.34	0.06	1.02	1.02	25.45	1272	1943	399.1
KK27	22.9	6.69	24.28	1.38	22.96	0.06	0.88	0.87	21.83	1092	1584	326.5
848	25.22	6.29	26.5	1.29	25.28	0.06	1.07	1.07	26.7	1335	2078	424.2
AB7	21.88	6.52	23.22	1.33	21.95	0.06	0.77	0.78	19.34	966.8	1453	296.4
Y21	16.52	6.68	17.96	1.45	16.58	0.06	1.06	1.06	26.45	1322	1830	395.7
DC26	18.66	6.66	19.94	1.29	18.72	0.06	1.23	1.21	30.44	1522	2363	456.8
K47	20.62	6.72	22.01	1.38	20.68	0.05	1.19	1.23	30.19	1509	2183	449.3
KK24	21.21	6.41	22.52	1.3	21.26	0.05	0.99	0.99	24.7	1235	1896	385.3
406A	22.07	6.55	23.35	1.28	22.13	0.06	1.11	1.11	27.69	1385	2164	422.8
A42	11.06	6.29	12.33	1.27	11.12	0.06	0.83	0.83	20.71	1035	1631	329.5
A5	12.48	6.52	13.8	1.32	12.54	0.06	1.07	1.06	26.57	1329	2016	407.5
A43	11.94	6.24	13.24	1.3	12	0.06	1.1	1.11	27.57	1378	2122	441.9
HS40	10.17	6.86	11.59	1.42	10.24	0.06	1.03	1.03	25.7	1285	1812	374.6
6T	10.39	6.71	11.82	1.43	10.45	0.06	0.64	0.62	15.72	785.9	1100	234.3
DC20	20.39	6.71	21.82	1.43	20.45	0.06	1.06	1.07	26.57	1329	1857	396.3
X33	22.34	6.57	23.7	1.37	22.39	0.05	1	1.01	25.07	1254	1836	381.8
X68	19.59	6.7	20.96	1.37	19.63	0.04	1	0.97	24.58	1229	1798	366.7
XC40	18.21	6.84	19.67	1.47	18.27	0.06	0.94	0.94	23.45	1173	1598	343
306C	24.68	6.57	26.09	1.41	24.74	0.06	0.93	0.91	22.95	1148	1624	349.2
											1867	383.5

Table C.2
Boil (no soak), Logan, Utah

Sample	Cruc. wt.	Wet wt.	Cruc. + Dry wt.	Dry Wt.	Cruc. + Ash wt.	Ash wt.	K(mg)	K(mg)	K(mg) /20ml	K(mg)/ L	K(mg) /100g Dry Wt.	K(mg) /100g Wet Wt.	% K loss
4M													
PB25	17.3	6.79	18.15	0.82	17.35	0.021	0.33	0.33	8.234	411.7	1009	121.3	
PY4	19.5	6.98	20.39	0.86	19.55	0.021	0.33	0.33	8.234	411.7	953	118	
B3P	16.5	6.21	17.28	0.83	16.47	0.02	0.32	0.31	7.859	393	948	126.6	
A15P	18.7	6.24	19.48	0.82	18.68	0.019	0.31	0.31	7.735	386.7	938.7	124	
												122.5	67.8
4X													
Y4	19.5	6.86	20.5	0.98	19.54	0.009	0.21	0.21	5.24	262	536.3	76.39	
Y35	17.2	5.2	18.04	0.84	17.22	0.013	0.18	0.18	4.491	224.6	537.8	86.37	
A15	18.7	6.14	19.53	0.87	18.67	0.013	0.2	0.2	4.99	249.5	572.2	81.34	
B25	17.3	5.45	18.19	0.86	17.34	0.009	0.19	0.18	4.616	230.8	538.6	84.69	
46	16.1	6.24	17.06	0.96	16.12	0.014	0.22	0.21	5.364	268.2	558.8	85.97	
Y38	17.3	6.37	18.16	0.88	17.3	0.014	0.2	0.19	4.865	243.3	556	76.44	
												81.86	78.5
6M													
P15M	10.4	6.15	11.3	0.95	10.39	0.033	0.55	0.57	13.97	698.6	1475	227.2	
PHS15	16	6.32	17.02	0.98	16.06	0.03	0.5	0.51	12.6	630	1283	199.3	
9PWP	21.2	6.29	22.17	0.98	21.23	0.031	0.55	0.56	13.85	692.4	1416	220.2	
D91P	10.6	6.54	11.61	1.02	10.62	0.032	0.41	0.41	10.23	511.5	1000	156.5	
A7P	17.7	6.27	18.66	0.97	17.72	0.029	0.45	0.45	11.23	561.4	1162	179	
												196.4	48.3
6X													
A11	17.9	6.4	18.93	1.06	17.89	0.022	0.44	0.45	11.1	555.1	1047	173.5	
31	17.3	5.37	18.24	0.93	17.34	0.023	0.35	0.35	8.733	436.6	941	162.7	
A6	19	6.22	20.09	1.06	19.05	0.026	0.44	0.43	10.85	542.7	1023	174.6	
Y20	20	6.18	21.11	1.12	20.02	0.028	0.42	0.42	10.48	524	938.1	169.5	
Y56	19	6.47	20.06	1.06	19.02	0.015	0.45	0.46	11.35	567.6	1073	175.5	
29	14.9	5.76	15.9	0.98	14.95	0.022	0.37	0.38	9.356	467.8	959.6	162.5	
												169.7	55.3
8M													
Y12	19.6	5.35	20.43	0.82	19.65	0.027	0.5	0.5	12.48	623.8	1531	233.4	
A31	18.1	5.99	19.13	1.04	18.12	0.032	0.61	0.62	15.34	767.2	1473	256.2	
58	16.4	5.57	17.33	0.97	16.38	0.023	0.52	0.51	12.85	642.5	1326	230.5	
S9	16.9	5.85	17.86	0.98	16.91	0.027	0.57	0.57	14.22	711.1	1451	243.3	
A119	16.6	6.89	17.7	1.14	16.6	0.034	0.64	0.65	16.09	804.6	1418	233.5	
Y25	19.3	6.61	20.35	1.07	19.31	0.034	0.69	0.68	17.09	854.5	1594	258.5	
												242.6	36.2
8X													
X25	22.4	6.79	23.44	1.03	22.42	0.021	0.44	0.44	10.98	548.9	1062	161.8	
X35	25.4	5.99	26.3	0.92	25.41	0.022	0.47	0.48	11.85	592.6	1290	197.9	
143A	21.7	6.67	22.67	1.01	21.69	0.028	0.46	0.46	11.48	573.9	1132	172.2	
PS4	23	5.81	23.84	0.84	23.03	0.026	0.42	0.41	10.35	517.7	1227	178.3	
21	29.4	6.91	30.43	1.06	29.4	0.029	0.5	0.5	12.48	623.8	1174	180.5	
												178.1	53.1

Table C.3
Boil (2-hour soak), Logan, Utah

Sample	Cruc. wt.	Wet wt.	Cruc. + Dry wt.	Dry Wt.	Cruc. + Ash wt.	Ash wt.	K(mg)	K(mg)	K(mg) /20ml	K(mg)/ L	K(mg) /100g Dry Wt.	K(mg) /100g Wet Wt.	% K loss
4M													
X30	22.68	6.36	23.6	0.9	22.7	0.02	0.3	0.3	7.485	374.3	836.3	117.7	
125A	23.17	6.42	24	0.87	23.18	0.014	0.3	0.3	7.485	374.3	864.3	116.7	
KK19	21.69	6.21	22.5	0.81	21.71	0.017	0.31	0.31	7.735	386.7	960.8	124.5	
842	26.15	6.01	27.1	0.9	26.18	0.021	0.26	0.26	6.487	324.4	724	107.9	
140A	22.03	6.29	22.9	0.87	22.05	0.02	0.28	0.29	7.111	355.5	817.3	113	
48PW	23.67	6.1	24.6	0.94	23.69	0.015	0.29	0.29	7.236	361.8	768.9	118.6	
												116.4	69
4X													
143AP	21.65	6.33	22.5	0.88	21.67	0.018	0.18	0.16	4.242	212.1	479.8	67.03	
6PWP	21.86	6.2	22.7	0.88	21.88	0.017	0.22	0.22	5.489	274.5	626.6	88.59	
Y44P	17.67	6.57	18.6	0.92	17.69	0.015	0.17	0.17	4.242	212.1	460	64.55	
PA46	11.82	6.33	12.7	0.89	11.84	0.013	0.26	0.26	6.487	324.4	728.9	102.5	
												80.65	79
6M													
H5	16.5	6.47	17.5	1.02	16.53	0.031	0.49	0.49	12.23	611.3	1194	189.1	
A118	15.57	6.5	16.6	1	15.6	0.029	0.51	0.52	12.85	642.5	1285	197.6	
Y48	20.36	6.23	21.3	0.98	20.39	0.028	0.48	0.48	11.98	598.8	1222	192.2	
HS15	16.03	6.22	17	0.95	16.06	0.029	0.46	0.47	11.6	580.1	1219	186.6	
Y44	17.67	6.45	18.7	1.06	17.7	0.031	0.5	0.5	12.48	623.8	1181	193.4	
												191.8	50
6X													
8431	24.8	6.64	25.9	1.07	24.81	0.011	0.34	0.34	8.483	424.2	792.8	127.8	
X66	22.42	6.08	23.4	0.94	22.44	0.02	0.34	0.35	8.608	430.4	919.6	141.6	
HS2	21.66	6.87	22.7	1.06	21.69	0.025	0.37	0.38	9.356	467.8	886	136.1	
DC72	24.82	6.12	25.8	1	24.84	0.02	0.35	0.35	8.733	436.6	873.3	142.6	
KK2	23.87	6.25	24.8	0.92	23.89	0.023	0.35	0.35	8.733	436.6	946.1	139.8	
												137.6	64
8M													
AB4	24.95	6.27	25.9	0.96	24.97	0.019	0.55	0.55	13.72	686.1	1428	218.8	
8	30.43	6.16	31.5	1.05	30.46	0.031	0.53	0.52	13.1	654.9	1250	212.6	
142A	22.45	6.73	23.5	1.03	22.48	0.032	0.6	0.61	15.09	754.7	1470	224.3	
333C	25.84	6.24	26.8	0.99	25.87	0.032	0.58	0.58	14.47	723.6	1459	232	
AB29	24.39	6.71	25.5	1.1	24.42	0.035	0.66	0.65	16.34	817.1	1491	243.5	
												226.2	40
8X													
35	16.97	6.8	18.2	1.2	16.99	0.026	0.53	0.48	12.6	630	1054	185.4	
41	15.57	7	16.8	1.23	15.59	0.027	0.42	0.43	10.6	530.2	863.5	151.6	
25	16.99	6.12	18	1.04	17.01	0.026	0.41	0.39	9.98	499	955.9	163	
42	16.3	6.71	17.5	1.18	16.33	0.025	0.49	0.48	12.1	605	1028	180.5	
												170.1	55

Table C.4
Boil (24-hour soak), Logan, Utah

Sample	Cruc. wt.	Wet wt.	Cruc. + Dry wt.	Dry Wt.	Cruc. + Ash wt.	Ash wt.	K(mg)	K(mg)	K(mg) /20ml	K(mg)/ L	K(mg) /100g Dry Wt.	K(mg) /100g Wet Wt.	% K loss
4M				D-B									
Y45	17.4	6.69	18.39	0.99	17.42	0.02	0.25	0.26	6.362	318.1	645.3	95.07	
A125	15.8	6.05	16.68	0.86	15.83	0.01	0.24	0.23	5.863	293.2	681	96.99	
A28	17.7	6.88	18.58	0.84	17.76	0.02	0.27	0.27	6.737	336.8	802.9	97.97	
												96.68	74.6
4X													
HS21	22.7	6.54	23.59	0.89	22.71	0	0.17	0.17	4.242	212.1	476.6	64.84	
PS2	21.9	6.4	22.8	0.88	21.93	0.01	0.2	0.19	4.865	243.3	553.5	76.03	
X09	18.8	6.27	19.68	0.83	18.86	0.01	0.18	0.19	4.616	230.8	553.4	73.66	
6PW	21.9	6.33	22.7	0.84	21.88	0.01	0.2	0.2	4.99	249.5	597.6	78.89	
AB20	23.8	5.35	24.49	0.74	23.77	0.01	0.18	0.18	4.491	224.6	609.4	83.99	
HS20	23	5.79	23.83	0.78	23.06	0.02	0.18	0.19	4.616	230.8	591.8	79.72	
												76.19	79.9
6M													
Y49	19.1	5.78	20.07	0.99	19.1	0.02	0.36	0.36	8.982	449.1	909.1	155.5	
AB36	25.1	6.9	26.24	1.16	25.1	0.01	0.41	0.4	10.1	505.2	874.9	146.4	
g	22.9	6.82	24.08	1.15	22.96	0.02	0.4	0.4	9.98	499	869.3	146.3	
8432	24.7	5.59	25.61	0.93	24.69	0.02	0.34	0.38	8.982	449.1	964.8	160.6	
												152.2	60
6X													
PY45	17.4	6.47	18.47	1.06	17.43	0.01	0.33	0.33	8.234	411.7	780.4	127.2	
33NP	11.5	6.08	12.47	0.99	11.5	0.02	0.31	0.31	7.735	386.7	782.1	127.1	
PX35	25.4	6.78	26.53	1.14	25.41	0.02	0.36	0.36	8.982	449.1	785.8	132.5	
A118P	15.6	6.57	16.67	1.11	15.59	0.02	0.3	0.3	7.485	374.3	677.4	114	
46P	16.1	6.6	17.19	1.09	16.13	0.02	0.31	0.3	7.61	380.5	701.4	115.3	
												123.2	67.6
8M													
KK2P	23.9	7.35	25.1	1.23	23.92	0.05	0.57	0.57	14.22	711.1	1154	193.5	
PY58	17.3	6.94	18.6	1.26	17.39	0.05	0.56	0.57	14.1	704.8	1120	203.1	
PA133	16.3	7.46	17.52	1.22	16.35	0.05	0.55	0.55	13.72	686.1	1129	183.9	
HS16P	16.1	7.23	17.34	1.22	16.17	0.05	0.54	0.56	13.72	686.1	1128	189.8	
HS2P	21.7	6.99	22.86	1.19	21.71	0.05	0.56	0.55	13.85	692.4	1162	198.1	
												193.7	49
8X													
39P	16.2	6.8	17.39	1.22	16.2	0.03	0.48	0.47	11.85	592.6	969.8	174.4	
T53P	17.9	6.41	19.05	1.15	17.93	0.02	0.46	0.46	11.48	573.9	1001	179.1	
D77P	10.3	6.57	11.48	1.18	10.33	0.03	0.41	0.41	10.23	511.5	869.1	155.7	
A115P	16.5	6.96	17.77	1.24	16.56	0.03	0.49	0.49	12.23	611.3	984.3	175.7	
PA17	18.1	6.31	19.25	1.14	18.14	0.03	0.44	0.44	10.98	548.9	962.1	174.1	
												171.8	54.8

Table C.5
Microwave (no soak), Logan, Utah

Sample	Cruc. wt.	Wet wt.	Cruc. + Dry wt.	Dry Wt.	Cruc. +Ash wt.	Ash wt.	K(mg)	K(mg)	K(mg) /20ml	K(mg)/ L	K(mg) /100g Dry Wt.	K(mg) /100g Wet Wt.	% K loss
4M													
PB29	17.4	6.99	18.58	1.17	17.4	0.026	0.35	0.35	8.733	436.6	746.4	124.9	
30P	15.9	6.69	17.07	1.12	16	0.023	0.36	0.36	8.982	449.1	799.8	134.3	
PCH85	16.3	6.49	17.43	1.15	16.3	0.019	0.34	0.34	8.483	424.2	739.6	130.7	
CH16P	16.7	6.26	17.78	1.09	16.7	0.022	0.39	0.39	9.731	486.5	893.5	155.4	
												136.3	64.1
4X													
845P	25.9	6.17	26.96	1.06	25.9	0.01	0.3	0.3	7.485	374.3	709.5	121.2	
320CP	23.6	6.13	24.66	1.05	23.6	0.011	0.28	0.28	6.986	349.3	666	114	
16PWP	21.6	6.73	22.71	1.13	21.6	0.02	0.34	0.32	8.234	411.7	726.1	122.3	
X16P	18.6	6.5	19.62	1.07	18.6	0.019	0.34	0.34	8.483	424.2	795.8	130.6	
S9P	16.9	6.57	17.95	1.07	16.9	0.019	0.35	0.34	8.608	430.4	802.2	130.9	
848P	25.2	6.65	26.29	1.07	25.2	0.015	0.35	0.35	8.733	436.6	813.8	131.2	
												125	67.1
6M													
AB4P	25	6.31	26.12	1.17	25	0.028	0.47	0.48	11.85	592.6	1016	187.7	
6TP	10.4	6.21	11.47	1.09	10.4	0.028	0.46	0.46	11.48	573.9	1058	184.8	
X05P	19.8	6.32	20.87	1.06	19.8	0.028	0.41	0.42	10.35	517.7	980.5	163.7	
												178.7	53
6X													
X06P	20.3	6.55	21.51	1.18	20.4	0.029	0.47	0.47	11.73	586.3	996.3	178.9	
V56	19	6.67	20.22	1.23	19	0.029	0.423	0.42	10.52	525.8	854.3	157.7	
ICH23	16.3	6.14	17.44	1.1	16.4	0.026	0.45	0.45	11.23	561.4	1021	182.9	
AB361	25.1	6.52	26.26	1.17	25.1	0.024	0.45	0.45	11.23	561.4	956.3	172.3	
8M												173	54.5
8X													
X53P	24.4	6.29	25.57	1.19	24.4	0.035	0.55	0.54	13.6	679.9	1146	216.2	
Y20P	20	6.87	21.28	1.29	20	0.038	0.63	0.63	15.72	785.9	1220	228.8	
P25	17	6.96	18.27	1.28	17	0.041	0.69	0.7	17.34	867	1350	249.2	
167AP	21.5	6.57	22.71	1.26	21.5	0.032	0.62	0.61	15.34	767.2	1221	233.7	
B23P	18.3	6.64	19.57	1.31	18.3	0.04	0.61	0.61	15.22	761	1162	229.2	
												231.4	39.1

Table C.6
Microwave (2-hour soak), Logan, Utah

Sample	Cruc. wt.	Wet wt.	Cruc. + Dry wt.	Dry Wt.	Cruc. + Ash wt.	Ash wt.	K(mg)	K(mg)	K(mg) /20ml	(mg)/ L	K(mg) /100g Dry Wt.	K(mg) /100g Wet Wt.	% K loss
4M													
126AP	22.65	6.79	23.6	0.95	22.67	0.02	0.27	0.28	6.861	343.1	723.8	101	
PB28	17.06	6.4	18	0.91	17.08	0.018	0.26	0.26	6.487	324.4	716	101.4	
42P	16.3	6.95	17.3	0.95	16.32	0.018	0.27	0.27	6.737	336.8	706.1	96.89	
PX25	22.4	6.83	23.3	0.93	22.42	0.015	0.27	0.27	6.737	336.8	721.3	98.62	
A5P	12.47	6.63	13.4	0.9	12.49	0.019	0.26	0.26	6.487	324.4	717.6	97.83	
												99.15	73.9
4X													
Y21P	16.51	6.42	17.4	0.89	16.52	0.01	0.19	0.2	4.865	243.3	549.7	75.82	
28P	16.45	6.58	17.4	0.95	16.46	0.012	0.18	0.19	4.616	230.8	486.4	70.17	
PB3	17.79	6.24	18.7	0.9	17.8	0.013	0.21	0.19	4.99	249.5	556.3	79.93	
PKK30	22.55	6.68	23.6	1.03	22.57	0.015	0.22	0.23	5.614	280.7	546.6	84.05	
												77.49	79.6
6M													
AB17P	23.32	6.81	24.5	1.23	23.35	0.026	0.47	0.48	11.85	592.6	967.4	174.1	
K30P	24.71	6.24	25.8	1.14	24.73	0.025	0.45	0.44	11.1	555.1	974.8	177.9	
Y12P	19.62	6.74	20.8	1.22	19.64	0.027	0.49	0.49	12.23	611.3	1005	181.4	
8456P	26.26	6.57	27.5	1.22	26.29	0.028	0.45	0.46	11.35	567.6	927.5	172.8	
V30	18.72	6.52	19.9	1.15	18.75	0.027	0.44	0.44	10.98	548.9	951.3	168.5	
52P	15.6	6.66	16.8	1.16	15.63	0.028	0.44	0.45	11.1	555.1	953.8	166.8	
												173.6	54.3
6X													
A42P	11.06	6.28	12.1	1.02	11.09	0.028	0.39	0.39	9.731	486.5	952.1	154.9	
8P	30.43	6.79	31.5	1.09	30.46	0.026	0.42	0.42	10.48	524	958.7	154.4	
PB30	17.49	6.71	18.6	1.09	17.52	0.025	0.39	0.39	9.731	486.5	891.1	145.1	
												151.5	60.1
8M													
P8432	24.68	6.25	25.8	1.17	24.71	0.033	0.49	0.48	12.1	605	1034	193.6	
A100P	16.83	6.09	18	1.13	16.86	0.028	0.53	0.53	13.22	661.2	1173	217.1	
gP	22.94	6.51	24.2	1.22	22.98	0.038	0.58	0.6	14.72	736	1206	226.1	
8431P	24.8	6.39	26.1	1.25	24.84	0.041	0.68	0.69	17.09	854.5	1364	267.6	
												226.1	40.5
8X													
158AP	22.69	6.46	23.8	1.11	22.72	0.029	0.34	0.35	8.608	430.4	772.7	133.4	
847P	25.07	6.89	26.2	1.1	25.09	0.024	0.4	0.4	9.98	499	911.4	144.8	
S16P	10.04	6.3	11.1	1.04	10.07	0.024	0.35	0.38	9.107	455.3	879.9	144.5	
PB10	11.08	6.29	12.2	1.08	11.1	0.019	0.38	0.37	9.356	467.8	867.1	148.7	
VIP	11.5	6.4	12.5	1.05	11.52	0.023	0.33	0.33	8.234	411.7	784.9	128.7	
												140	63.2

Table C.7
Microwave (24-hour soak), Logan, Utah

Sample	Cruc. wt.	Wet wt.	Cruc. + Dry wt.	Dry Wt.	Cruc. + Ash wt.	Ash wt.	K(mg)	K(mg)	K(mg) /20ml	K(mg)/ L	K(mg) /100g Dry Wt.	K(mg) /100g Wet Wt.	% K loss
4M													
A31P	18.1	6.27	18.93	0.84	18.09	0.012	0.16	0.18	4.242	212.1	502	67.69	
100P	18.2	6.76	19.11	0.89	18.24	0.012	0.2	0.2	4.99	249.5	562.6	73.79	
58P	16.3	6.2	17.2	0.85	16.36	0.013	0.15	0.14	3.618	180.9	426.6	58.34	
PK45	23.5	6.18	24.31	0.84	23.48	0.015	0.14	0.15	3.618	180.9	431.2	58.54	
145AP	22.4	6.9	23.28	0.9	22.4	0.023	0.17	0.16	4.117	205.8	458.4	59.64	
												63.6	83
4X													
PPS1	24.9	6.36	25.73	0.83	24.91	0.012	0.11	0.11	2.745	137.2	330.3	43.15	
8465P	25.5	6.66	26.39	0.88	25.52	0.015	0.11	0.11	2.745	137.2	310.5	41.2	
E17P	17.1	6.46	17.92	0.87	17.07	0.014	0.12	0.12	2.994	149.7	345.3	46.33	
PY18	18.3	6.54	19.18	0.87	18.32	0.011	0.11	0.11	2.745	137.2	314	41.95	
109AP	23.5	6.52	24.39	0.87	23.53	0.013	0.14	0.13	3.368	168.4	386.7	51.7	
PHS10	18.5	6.32	19.34	0.88	18.48	0.014	0.13	0.14	3.368	168.4	384.5	53.31	
												46.27	88
6M													
PDC72	24.8	6.56	25.92	1.1	24.85	0.02	0.26	0.26	6.487	324.4	592.4	98.93	
PY38	17.3	6.53	18.31	1.02	17.31	0.023	0.28	0.28	6.986	349.3	686.2	107	
P332C	26	6.88	27	1.04	25.98	0.021	0.3	0.32	7.735	386.7	741.6	112.5	
163AP	21.7	6.26	22.74	1	21.75	0.018	0.27	0.27	6.737	336.8	671.6	107.7	
PA24	11.8	6.87	12.89	1.05	11.86	0.019	0.23	0.23	5.739	286.9	546	83.59	
												101.9	73
6X													
A10P	17.9	6.23	18.88	0.94	17.96	0.013	0.2	0.2	4.99	249.5	532.6	80.1	
PX09	18.8	6.84	19.85	1.01	18.86	0.017	0.23	0.23	5.739	286.9	568.2	83.91	
PY48	20.4	6.65	21.35	1	20.38	0.019	0.19	0.21	4.99	249.5	501.5	75.04	
A28P	17.7	6.43	18.63	0.89	17.76	0.015	0.23	0.22	5.614	280.7	630.1	87.36	
												81.6	79
8M													
A32P	18.5	6.4	19.62	1.16	18.49	0.027	0.49	0.48	12.1	605	1040	189.1	
PK40	24.1	6.43	25.39	1.26	24.16	0.027	0.51	0.51	12.72	636.2	1014	198	
PAB2	26.4	6.36	27.67	1.25	26.46	0.032	0.5	0.49	12.35	617.5	988.8	194.2	
8416P	22.1	6.73	23.36	1.31	22.09	0.039	0.54	0.53	13.35	667.4	1020	198.4	
HS7P	23.1	6.68	24.35	1.26	23.14	0.041	0.51	0.51	12.72	636.2	1014	190.4	
160AP	22.9	6.34	24.16	1.22	22.98	0.04	0.5	0.52	12.72	636.2	1044	200.8	
												195.2	49
8X													
24P	15.8	6.62	17	1.17	15.86	0.029	0.34	0.36	8.733	436.6	743.8	131.8	
PPS2	21.9	6.63	23.11	1.19	21.95	0.029	0.41	0.4	10.1	505.2	849.9	152.5	
PHS20	23	6.37	24.17	1.12	23.08	0.028	0.43	0.43	10.73	536.4	954.5	168.5	
PA125	15.8	6.64	17.06	1.24	15.85	0.029	0.43	0.43	10.73	536.4	865.2	161.5	
												153.6	60

Table C.8
Pressure cook (no soak), Logan, Utah

Sample	Cruc. wt.	Wet wt.	Cruc. + Dry wt.	Dry Wt.	Cruc. + Ash wt.	Ash wt.	K(mg)	K(mg)	K(mg) /20ml	K(mg)/ L	K(mg) /100g Dry Wt.	K(mg) /100g Wet Wt.	% K loss
4M													
Y28	18.6	6.38	19.45	0.88	18.59	0.016	0.27	0.26	6.612	330.6	748.8	103.6	
30	15.9	5.68	16.71	0.77	15.96	0.013	0.28	0.24	6.487	324.4	842.5	114.3	
24	15.8	6.95	16.76	0.92	15.85	0.017	0.27	0.28	6.861	343.1	741.8	98.75	
Y5	19.7	7.23	20.71	1.01	19.72	0.023	0.27	0.26	6.612	330.6	656.6	91.51	
												102	73
4X													
39	16.2	6.97	17.11	0.95	16.19	0.02	0.25	0.24	6.113	305.6	646.9	87.69	
37	16.7	6.63	17.59	0.9	16.7	0.018	0.24	0.24	5.988	299.4	662.4	90.29	
A17	18.1	5.88	18.89	0.78	18.13	0.019	0.2	0.2	4.99	249.5	641.4	84.91	
HS16	16.1	6.92	17.03	0.91	16.13	0.011	0.26	0.24	6.238	311.9	687.7	90.1	
												88.25	77
6M													
15PW	23.2	6.56	24.13	0.95	23.21	0.025	0.42	0.42	10.48	524	1101	159.8	
X69	26.1	6.7	27.06	0.97	26.12	0.025	0.42	0.42	10.48	524	1083	156.5	
K45	23.5	6.64	24.42	0.95	23.5	0.029	0.43	0.44	10.85	542.7	1145	163.5	
111A	23.6	6.66	24.55	0.96	23.62	0.03	0.43	0.43	10.73	536.4	1120	161.2	
												160.2	58
6X													
Y58	17.3	6.67	18.36	1.02	17.36	0.023	0.33	0.32	8.109	405.4	791.9	121.6	
Y3	15.2	6.99	16.29	1.05	15.26	0.023	0.36	0.35	8.857	442.9	845.2	126.8	
Y43	18.8	6.2	19.73	0.96	18.79	0.017	0.33	0.33	8.234	411.7	859.4	132.8	
B3	17.8	6.01	18.71	0.92	17.81	0.019	0.29	0.29	7.236	361.8	782.2	120.4	
Y53	17.9	6.47	18.94	1.04	17.92	0.019	0.31	0.3	7.61	380.5	732.4	117.6	
Y30	18.7	6.13	19.66	0.95	18.74	0.018	0.27	0.29	6.986	349.3	738.5	113.9	
												122.2	68
8M													
117A	21.7	6.81	22.79	1.09	21.73	0.029	0.48	0.48	11.98	598.8	1098	176	
9PW	21.2	7.15	22.33	1.13	21.23	0.029	0.53	0.53	13.22	661.2	1166	184.8	
B23	18.3	6.78	19.42	1.16	18.3	0.03	0.43	0.43	10.73	536.4	927.3	158.2	
28	16.4	6.22	17.43	0.98	16.48	0.035	0.42	0.42	10.48	524	1064	168.5	
Y37	19.3	5.81	20.27	0.93	19.36	0.022	0.43	0.43	10.73	536.4	1151	184.7	
A32	18.5	6.13	19.51	1.04	18.49	0.023	0.42	0.41	10.35	517.7	991.8	169	
8X												173.6	54
8450	25.7	6.98	26.72	1.04	25.72	0.032	0.43	0.43	10.73	536.4	1037	153.8	
AB17	23.3	6.44	24.25	0.94	23.35	0.037	0.45	0.46	11.35	567.6	1206	176.2	
H3	23.5	6.48	24.46	0.97	23.52	0.033	0.41	0.41	10.23	511.5	1057	157.9	
160A	23	6.43	23.88	0.93	22.98	0.027	0.53	0.52	13.1	654.9	1407	203.9	
60108	19.5	6.68	20.49	0.97	19.55	0.033	0.45	0.43	10.98	548.9	1127	164.4	
335C	25.3	6.48	26.2	0.95	25.29	0.032	0.41	0.41	10.23	511.5	1082	157.9	
												169	56

Table C.9
Pressure cook (2-hour soak), Logan, Utah

Sample	Cruc. wt.	Wet wt.	Cruc. + Dry wt.	Dry Wt.	Cruc. + Ash wt.	Ash wt.	K(mg)	K(mg)	K(mg) /20ml	K(mg)/ L	K(mg) /100g Dry Wt.	K(mg) /100g Wet Wt.	% K loss
4M													
X53	24.4	6.66	25.2	0.8	24.4	0.01	0.23	0.23	5.739	286.9	719.11	86.125	
HS3	23.6	6.52	24.3	0.8	23.57	0.013	0.2	0.2	4.99	249.5	627.67	76.557	
KK6	23.5	6.79	24.4	0.85	23.55	0.016	0.19	0.19	4.741	237	556.4	69.867	
8456	26.3	6.55	27.1	0.81	26.27	0.011	0.19	0.19	4.741	237	585.25	72.341	
308C	24.5	6.76	25.3	0.81	24.49	0.013	0.19	0.19	4.741	237	581.66	70.178	
X52	22	6.71	22.8	0.81	22.01	0.013	0.2	0.2	4.99	249.5	616.81	74.322	
												74.898	80.3
4X													
320C	23.6	6.55	24.5	0.84	23.64	0.018	0.18	0.18	4.491	224.6	534.64	68.586	
167A	21.4	6.54	22.3	0.84	21.46	0.013	0.16	0.16	3.992	199.6	475.8	61.049	
PS1	24.9	6.62	25.7	0.83	24.91	0.016	0.16	0.17	4.117	205.8	493.62	62.205	
845	25.9	6.56	26.7	0.84	25.92	0.015	0.18	0.18	4.491	224.6	532.11	68.502	
KK22	23.5	6.52	24.4	0.82	23.56	0.013	0.18	0.19	4.616	230.8	560.84	70.848	
												66.238	82.6
6M													
38	15	6.11	15.8	0.86	14.98	0.024	0.35	0.35	8.733	436.6	1017.8	143.02	
B29	17.4	5.78	18.3	0.87	17.43	0.02	0.31	0.32	7.859	393	902.32	136	
52	15.6	6.1	16.5	0.9	15.62	0.019	0.28	0.27	6.861	343.1	761.51	112.53	
HS10	18.5	6.28	19.4	0.92	18.49	0.021	0.31	0.31	7.735	386.7	844.38	123.1	
												128.66	66.1
6X													
145A	22.4	6.7	23.4	0.98	22.41	0.02	0.26	0.26	6.487	324.4	663.29	96.85	
X06	20.3	6.76	21.3	1.01	20.35	0.023	0.29	0.3	7.36	368	729.46	108.9	
109A	23.5	6.74	24.5	1	23.54	0.025	0.26	0.28	6.737	336.8	675	100.02	
849	25.4	6.72	26.4	1	25.46	0.023	0.31	0.31	7.735	386.7	776.56	115.03	
X56	24.4	6.8	25.4	1.01	24.38	0.023	0.3	0.3	7.485	374.3	739.62	110.09	
												106.18	72.1
8M													
1P	23.5	6.46	24.5	1.03	23.53	0.031	0.42	0.42	10.48	524	1014.4	162.29	
152AP	22.5	6.17	23.5	0.97	22.58	0.03	0.43	0.42	10.6	530.2	1095.4	171.94	
335CP	25.3	6.1	26.2	0.97	25.29	0.028	0.41	0.41	10.23	511.5	1055.7	167.83	
308CP	24.5	6.3	25.4	0.95	24.51	0.028	0.46	0.45	11.35	567.6	1192.5	180.19	
DC58P	24.5	6.14	25.4	0.98	24.49	0.027	0.41	0.41	10.23	511.5	1047	166.6	
106AP	22.1	6.8	23.2	1.11	22.1	0.034	0.45	0.44	11.1	555.1	1000.2	163.28	
												168.69	55.6
8X													
DC58	24.5	6.22	25.4	0.96	24.48	0.022	0.39	0.38	9.606	480.3	1001.6	154.56	
152A	22.6	6.5	23.5	0.99	22.58	0.026	0.38	0.39	9.606	480.3	974.21	147.78	
AB2	26.4	6.26	27.4	0.95	26.45	0.026	0.37	0.38	9.356	467.8	990.08	149.53	
302C	24.4	6.6	25.4	0.97	24.47	0.026	0.43	0.48	11.35	567.6	1165.5	171.9	
65PW	23.4	6.52	24.3	0.96	23.38	0.027	0.4	0.4	9.98	499	1037.4	153.14	
DC5	19.8	6.79	20.8	1.01	19.86	0.028	0.44	0.45	11.1	555.1	1104.8	163.56	
												156.75	59

Table C.10
Pressure cook (24-hour soak), Logan, Utah

Sample	Cruc. wt.	Wet wt.	Cruc. + Dry wt.	Dry Wt.	Cruc. + Ash wt.	Ash wt.	K(mg)	K(mg)	K(mg) /20ml	K(mg)/ L	K(mg) /100g Dry Wt.	K(mg) /100g Wet Wt.	% K loss
4M													
31P	17.3	5.88	18.15	0.83	17.33	0.009	0.09	0.09	2.246	112.3	269.2	38.19	
PPS4	23	6.87	23.96	0.96	23.01	0.007	0.12	0.12	2.994	149.7	312.9	43.6	
DC5P	19.8	6.2	20.72	0.89	19.84	0.009	0.12	0.14	3.244	162.2	365.3	52.29	
AB29P	24.4	6.18	25.23	0.84	24.4	0.007	0.12	0.13	3.119	155.9	372.6	50.51	
PY43	18.8	6.61	19.71	0.93	18.78	0.007	0.11	0.12	2.869	143.5	307.2	43.4	
PAB20	23.8	6.49	24.68	0.93	23.77	0.008	0.14	0.13	3.368	168.4	364.1	51.92	
												46.65	87.7
4X													
Y3P	15.2	6.54	16.07	0.84	15.25	0.01	0.07	0.07	1.747	87.33	209.2	26.7	
P142A	22.4	6.04	23.27	0.82	22.46	0.007	0.09	0.09	2.246	112.3	275.2	37.16	
Y7P	16.9	6.29	17.76	0.86	16.91	0.005	0.08	0.07	1.871	93.56	218.3	29.77	
X66P	22.4	6.31	23.25	0.82	22.43	0.004	0.05	0.06	1.372	68.61	166.7	21.75	
A11P	17.9	6.81	18.76	0.89			0.08	0.08	1.996	99.8	223.8	29.3	
												28.94	92.4
6M													
849P	25.4	6.45	26.45	1.01	25.47	0.028	0.34	0.35	8.608	430.4	848.9	133.5	
PY5	19.7	6.58	20.74	1.05	19.72	0.025	0.32	0.31	7.859	393	750.6	119.4	
PKK22	23.5	6.83	24.64	1.1	23.57	0.027	0.37	0.36	9.107	455.3	827.9	133.4	
KK6P	23.5	6.76	24.61	1.08	23.55	0.026	0.36	0.36	8.982	449.1	829.4	132.8	
PX52	22	6.97	23.13	1.14	22.02	0.027	0.34	0.32	8.234	411.7	724.8	118.1	
38P	15	6.28	15.94	0.99	14.98	0.027	0.35	0.35	8.733	436.6	884.8	139	
												129.4	66
6X													
P65PW	23.3	6.46	24.32	0.98	23.37	0.023	0.28	0.29	7.111	355.5	727.8	110	
PY25	19.3	6.49	20.27	0.99	19.3	0.02	0.26	0.25	6.362	318.1	644	97.97	
132AP	22	6.95	23.05	1.04	22.03	0.023	0.3	0.28	7.236	361.8	695.7	104.1	
P32PW	23.7	6.72	24.71	0.98	23.75	0.019	0.25	0.25	6.238	311.9	637.8	92.82	
PKK24	21.2	6.42	22.19	0.99	21.22	0.021	0.27	0.28	6.861	343.1	695.9	106.9	
												102.4	73.1
8M													
126A	22.6	6.52	23.68	1.03	22.67	0.025	0.39	0.41	9.98	499	968.9	153.1	
K40	24.1	6.4	25.15	1.02	24.16	0.024	0.36	0.36	8.982	449.1	884.1	140.4	
23A	20.9	6.31	21.9	1.02	20.91	0.031	0.39	0.39	9.731	486.5	950.2	154.2	
K30	24.7	6.6	25.73	1.02	24.74	0.032	0.42	0.43	10.6	530.2	1038	160.7	
105PW	22.8	6.75	23.85	1.06	22.84	0.038	0.41	0.41	10.23	511.5	969.6	151.6	
												152	60
8X													
PX69	26.1	7.34	27.15	1.06	26.12	0.027	0.4	0.4	9.98	499	938.9	136	
P60108	19.5	6.89	20.61	1.09	19.55	0.03	0.41	0.41	10.23	511.5	941.1	148.5	
15PWP	23.2	6.51	24.27	1.09	23.21	0.027	0.38	0.38	9.481	474.1	873	145.7	
K47P	20.6	7.13	21.68	1.07	20.64	0.029	0.36	0.36	8.982	449.1	841	126	
HS19P	25.4	6.99	26.41	1.05	25.38	0.024	0.4	0.41	10.1	505.2	963.3	144.6	
												140.1	63.1

Table C.11
Washington state raw potato values

Sample	Cruc. wt.	Wet wt.	Dry Wt.	Cruc. + Ash	Ash wt.	K(mg) /20ml	K(mg) /100g Dry Wt.	K(mg) /100g Wet Wt.
H23	53.5	14.55	3.45	53.65	0.15	79.3	2300	545
YX5	51.48	16.55	3.99	51.63	0.15	94.5	2369	571
YX2	51.45	12.54	3.07	51.55	0.1	65.33	2127	521
YX11	50.23	15.51	3.6	50.37	0.14	79.72	2216	514
7F	49.74	17.43	4.29	49.93	0.19	107.4	2504	616
P70	49.36	16.89	3.8	49.55	0.19	83.1	2187	492
6F	48.48	18.32	4.07	48.69	0.21	88.67	2180	484
YX6	52.19	15.77	3.61	52.34	0.15	78.53	2175	498
P68	50.4	16.11	3.53	50.56	0.16	101.8	2886	632
H24	51.33	18.3	4.14	51.5	0.17	117.1	2832	640
H9	49.91	17.98	3.63	50.09	0.18	117.8	3243	655
H19	51.71	18.5	4.15	51.88	0.17	114.9	2768	621
P61	58.18	15.44	3.17	58.33	0.15	81.21	2566	526
H8	52.46	14.69	3.28	52.59	0.13	75.07	2291	511
P62	57.24	15.66	3.46	57.39	0.15	70	2023	447
YX9	50.64	20.63	4.83	50.86	0.22	119	2466	577
P65	58.37	22.52	5.47	58.6	0.23	118	2156	524
H12	51	19.48	4.31	51.2	0.2	137.9	3204	708
H15	56.96	17.59	3.73	57.13	0.17	93.05	2495	529
P69	48.67	19.27	4.55	48.87	0.2	89.8	1975	466
X35	25.41	21.76	4.74	25.65	0.24	104	2193	478
601	58.12	21.2	4.71	58.32	0.2	144.4	3068	681
S21	11.28	17.75	4.17	11.48	0.2	101.9	2443	574
P67	60.01	20.82	4.73	60.22	0.21	113.1	2392	543
305	55.13	23.78	5.14	55.37	0.24	124.4	2421	523
YX4	50.71	24.18	4.98	50.94	0.23	156.4	3141	647
YX1	54.73	25.2	5.47	54.98	0.25	148.4	2714	589
R2	52.79	26.86	6.12	53.05	0.26	158.5	2588	590
P89	56.06	24.8	5.28	56.29	0.23	145.3	2751	586
P6	60.01	23.29	5.52	60.23	0.22	140.4	2544	603
P64	52.93	27	6.08	53.17	0.24	160.7	2644	595
33N	11.49	19.71	4.49	11.7	0.21	119.2	2654	605
A5	12.47	20.11	4.16	12.7	0.23	123.3	2961	613
YX3	50.96	28.61	5.84	51.26	0.3	176.5	3025	617
X52	22	24.65	5.37	22.28	0.28	130.9	2436	531
G	22.94	5.39	1.1	23	0.06	34.71	3147	644
KK27	22.91	5.24	1.07	22.97	0.06	30.44	2843	581
8435	25.11	5.35	1.13	25.17	0.06	28.84	2559	539
AB24	23.65	5.15	1.08	23.7	0.05	27.66	2558	537
AB36	25.08	5.83	1.2	25.14	0.06	31.25	2595	536
330C	25.19	5.74	1.17	25.24	0.05	36.51	3128	636
							2460	**542.4**

Table C.12
EDTA, citrate, cold & hot water, Washington state

Sample	Cruc. wt.	Wet wt.	Cruc. + Dry	Dry wt.	Cruc. + Ash	Ash wt.	K(mg) /20ml	K(mg) /100g Dry Wt.	K(mg) /100g Wet Wt.	% K loss
EDTA										
X44	19.24	5.67	20.24	1	19.27	0.03	12.7	1271	224	
16PW	21.58	5.61	22.53	0.95	21.61	0.03	16.83	1779	300	
DC18	19.64	5.58	20.63	0.99	19.67	0.03	16.68	1678	299	
									274.3	49
.25%Citrate										
845	25.9	5.81	27.05	1.15	25.92	0.02	16.94	1478	291.5	
AB20	23.76	5.46	24.85	1.09	23.78	0.02	11.77	1084	215.5	
6PW	21.87	5.66	22.99	1.12	21.89	0.02	25.05	2234	442.5	
									316.5	42
.5%Citrate										
X68	19.58	5.32	20.58	1	19.6	0.02	15.72	1572	295.5	
21	29.37	5.61	30.49	1.12	29.39	0.02	27.15	2435	484	
847	25.06	5.89	26.15	1.09	25.08	0.02	13.52	1237	229.5	
									336.3	38
1%Citrate										
132A	22.01	5.55	23.1	1.09	22.04	0.03	17.54	1610	316	
332C	25.96	5.65	27.02	1.06	25.99	0.03	19.01	1792	336.5	
KK6	23.53	5.79	24.63	1.1	23.56	0.03	11.7	1062	202	
									284.8	47
Cold water										
DC5	19.84	5.54	20.77	0.93	19.87	0.03	13.05	1406	235.5	
848	25.22	5.64	26.19	0.97	25.25	0.03	14.75	1516	261.5	
X27	21.62	5.78	22.6	0.98	21.65	0.03	15.43	1573	267	
									254.7	53
Hot water										
X37	22.69	5.52	23.72	1.03	22.72	0.03	13.8	1339	250	
X33	22.34	5.44	23.26	0.92	22.37	0.03	15.67	1703	288	
AB17	23.32	5.76	24.35	1.03	23.35	0.03	13.62	1328	236.5	
									258.2	52

Table C.13
Agitated potatoes, Washington state

Sample	Cruc. wt.	Wet wt.	Cruc.+ Ash Wt.	Ash wt.	K(mg) /20ml	K(mg) /100g Wet wt.	% K Loss
4A (4 mm, 2H Soak, Agitated)							
H17	48.26	7.97	48.29	0.03	14.12	177.2	
P62	57.2	7.78	57.23	0.03	14.25	183.1	
H15	56.93	7.64	56.96	0.03	14.94	195.5	
P73	52.47	7.85	52.5	0.03	19.74	251.5	
P69	48.65	7.74	48.67	0.02	13.56	175.2	
P61	58.14	7.51	58.17	0.03	14.62	194.7	
						196.2	64
6A (6mm, 2H Soak, Agitated)							
H8	52.41	7.27	52.45	0.04	15.51	213.3	
P64	52.88	7.68	52.92	0.04	15.98	208	
H22	55.53	7.73	55.57	0.04	14.54	188.1	
H21	56.21	7.78	56.25	0.04	15.53	199.6	
P67	59.97	7.52	60.01	0.04	17.47	232.3	
YX5	51.44	7.65	51.48	0.04	15.29	199.9	
						206.9	62
8A (8mm, 2H Soak, Agitated)							
305	52.76	7.91	52.81	0.05	21.58	272.8	
H12	50.97	7.82	51.02	0.05	20.5	262.1	
H4	49.68	7.77	49.73	0.05	18.66	240.2	
H23	53.46	7.84	53.51	0.05	17.14	218.6	
H18	49.58	7.65	49.63	0.05	17.58	229.8	
H24 (Ash	51.29	8.07	51.34	0.05	21.46	265.9	
						248.2	54

Table C.14
Tomato sauce data

Sample	Cruc. wt.	Wet wt.	Cruc. + Dry wt.	Dry Wt.	Cruc.+ Ash wt.	Ash wt.	K(mg) /20ml	K(mg) /100g	Na(mg) /20ml	Na(mg) /100g
Untreated tomato sauce										
Brand A										
AB36	59.98	7.82	60.5	0.56	60.16	0.18	31.76	406.1	38	485.9
S9	22	5.08	22.6	0.55	22.12	0.12	23.21	456.9	25	492.1
KK6	50.62	7.57	51.2	0.55	50.79	0.17	25.71	339.6	36	481.6
21	50.67	7.41	51.2	0.54	50.85	0.18	24.57	331.6	34	457.9
Brand B								**383.6**		
K30	50.94	7.53	51.5	0.52	51.08	0.14	26.54	352.5	22	292.2
P8	21.68	5.08	22.2	0.52	21.79	0.11	23.9	470.5	16	315
6PW	54.71	8	55.2	0.51	54.85	0.14	24.87	310.9	25	312.5
15PW	58.08	7.94	58.6	0.51	58.21	0.13	30.33	382	23	294.6
Brand C								**379**		
AB20	49.71	7.79	50.3	0.58	49.77	0.06	21.45	275.4	0.5	6.4
X37	51.67	7.81	52.3	0.6	51.73	0.06	29.22	374.1	0.5	6
X44	58.34	8.2	58.9	0.56	58.4	0.06	28.43	346.7	0.6	7
1st Centrifuge								**332.1**		
Brand A										
143A	10.36	6.01	11.9	1.5	10.48	0.12	15.88	264.2		
DC18	10.1	6.07	11.9	1.78	10.23	0.13	13.87	228.5		
16PW	10.42	6.01	11.9	1.49	10.55	0.13	14.33	238.4		
Brand B								**243.7**		
K45	10.61	6.05	12.1	1.53	10.71	0.1	13.24	218.8		
330C	10.59	6.26	12.6	2	10.7	0.11	14.17	226.4		
845P	10.3	6.39	12.1	1.29	10.41	0.11	14.24	222.8		
Brand C								**222.7**		
143B	11.84	5.76	13.1	1.26	11.88	0.04	16.96	294.4		
12PW	11.13	5.9	12.4	1.29	11.18	0.05	17.57	297.8		
X31	11.05	6.16	12.6	1.57	11.1	0.05	18.37	298.2		
2nd Centrifuge								**296.8**		
Brand A										
K35	22.68	6.78	23.9	1.18	22.72	0.04	5.74	84.7		
C19	25.91	6.74	27.2	1.32	25.94	0.03	4.55	67.5		
330P	21.67	6.57	23.4	1.74	21.7	0.03	4.86	74		
Brand B								**75.4**		
215D	19.63	6.27	20.6	0.98	19.65	0.02	3.83	61.1		
Y76	23.48	6.56	24.7	1.26	23.5	0.02	4.46	68		
X30	25.19	6.33	26.6	1.45	25.21	0.02	3.53	55.8		
Brand C								**61.63**		
P10	21.87	6.45	23	1.12	21.88	0.01	4.63	71.8		
C66	23.18	6.66	24.3	1.09	23.2	0.02	4.49	67.4		
X	23.77	6.48	24.8	0.98	23.78	0.01	3.93	60.6		
3rd Centrifuge								**66.6**		
Brand A										
D77	10.3	7.63	10.8	0.5	10.33	0.03	3.61	47.3	2.5	32.8
D91	11.13	7.54	11.6	0.5	11.16	0.03	2.92	38.7	2.2	28.8
T1	10.59	7.91	11.1	0.5	10.62	0.03	3.98	50.3	2	25.3
A24	9.91	7.28	10.5	0.6	9.93	0.02	3.68	50.5	1.9	25.1
Brand B								**46.7**		
T23	10.61	7.55	11	0.4	10.63	0.02	3.42	45.3	1	12.6
15M	10.36	7.48	10.8	0.4	10.38	0.02	3.65	48.8	0.9	12.2
33NT	10.1	7.98	10.5	0.4	10.12	0.02	3.45	43.2	1	12.8
Brand C								**45.77**		
D74	10.43	7.96	10.8	0.4	10.44	0.01	3.14	39.4	0	0
D13	11.84	7.94	12.2	0.4	11.85	0.01	3.21	40.4	0	0
D5	10.13	7.89	10.53	0.4	10.14	0.01	3.16	40.6	0	0
								40.13		

APPENDIX D

Statistical Analysis of the Data

Table D.1
Multiple analysis of variance for change in mean potassium value of potatoes according to method of cooking, volume of water, and slice thickness

Source	D.F.	SS	MS	F Ratio	F Prob.
Within Cells	218	22870.12	104.91		
Method	8	112464.04	14058.01	134.00	0.000
Thickness	2	154217.52	77108.76	735.01	0.000
Volume	1	1723.15	1723.15	16.43	0.000
Method by Thickness	16	20979.92	1311.24	12.50	0.000
Method by Volume	8	10331.33	1291.42	12.31	0.000
Thickness by Volume	2	458.37	229.18	2.18	0.115
Method by Thickness by Volume	15	10589.13	705.94	6.73	0.000

Tests for Homogeneity of Variances
Cochran C = Max. Variance/Sum(Variances) = 0.1592, P = 0.455 (Approx.)
Bartlett-Box F = 1.466, P = 0.164

Table D.2
Significant differences between potato cooking methods using LSD procedure

Mean K value	Group	PC24	MW24	PC2	B24	PCNS	MW2	B2	BNS	MWNS
100.85	PC24									
107.23	MW24									
118.03	PC2									
135.70	B24	*	*							
137.72	PCNS	*	*							
144.87	MW2	*	*	*						
154.47	B2	*	*	*						
166.49	BNS	*	*	*	*	*				
167.37	MWNS	*	*	*	*	*				

(*) DENOTES PAIRS OF GROUPS SIGNIFICANTLY DIFFERENT AT THE 0.05 LEVEL.
PC=Pressure Cook,MW=Microwave,B=Boil, 24=24 hour soak, 2=2 hour soak, NS=No soak.

Table D.3
Significant differences between potassium values of potatoes according to slice thickness using the LSD procedure

Mean K value	Group	4mm	6mm	8mm
	4mm			
143.36	6mm	*		
181.52	8mm	*	*	

(*) DENOTES PAIRS OF GROUPS SIGNIFICANTLY DIFFERENT AT THE 0.05 LEVEL.

Table D.4
Significant differences between potassium values of potatoes according to volume of water using LSD procedure

Mean K value	Group	2 liter water	1 liter water
	2 L water		*
148.23	1 L water	*	

(*) DENOTES PAIRS OF GROUPS SIGNIFICANTLY DIFFERENT AT THE 0.05 LEVEL.

Table D.5
Analysis of variance for change in potassium values in potatoes according to the top 10 leaching methods

Source	D.F.	SS	MS	F Ratio	F Prob.
Between Groups	9	1397929.860	155325.5400	2.8735	0.0038
Within Groups	146	7892055.774	54055.1765		
Total	155	9289985.634			

Tests for Homogeneity of Variances

Cochrans C = Max. Variance/Sum(Variances) = 0.1794, P = 0.220 (Approx.)

Bartlett-Box F = 0.984, P = 0.451

Table D.6
Significant differences among top 10 potato cooking methods using LSD procedure

Mean K value (mg/100g)	Method	1	2	3	4	5	6	7	8	9	10
28.94	1										
46.27	2	*									
46.65	3	*									
63.58	4	*	*	*							
66.22	5	*	*	*							
74.90	6	*	*	*							
76.18	7	*	*	*							
77.50	8	*	*	*	*	*	*				
80.65	9	*	*	*	*	*	*	*			
81.86	10	*	*	*	*	*	*	*			

(*) DENOTES PAIRS OF GROUPS SIGNIFICANTLY DIFFERENT AT THE 0.05 LEVEL.

Table D.7
Analysis of variance for potassium value of tomato sauce according to method of preparation and brand of sauce

Source	D.F.	SS	MS	F Ratio	F Prob.
Within Cells	26	30614.65	1177.49		
Method	3	675609.64	225203.21	191.26	0.000
Brand	2	694.93	347.47	.30	0.747
Method by Brand	6	13827.40	2304.57	1.96	0.109

Table D.8
Analysis of variance for sodium value of tomato sauce according to method of preparation and brand of sauce

Source	D.F.	SS	MS	F Ratio	F Prob.
Within Cells	26	1130.83	43.49		
Method	3	6901183.13	2300394.4	52890.66	0.000
Brand	2	94498.72	47249.36	1086.36	0.000
Method by Brand	6	267642.01	44607.00	1025.60	0.000

Table D.9
Analysis of variance for flavor score of mashed potatoes according to preparation method and patient status

Source	D.F.	SS	MS	F Ratio	F Prob.
Within Cells	399	764.72	1.92		
Method	3	4.29	1.43	0.75	0.525
Status by Method	3	5.09	1.70	0.89	0.448

Table D.10
Analysis of variance for texture score of mashed potatoes according to preparation method and patient status

Source	D.F.	SS	MS	F Ratio	F Prob.
Within Cells	399	746.20	1.87		
Method	3	3.91	1.30	0.71	0.555
Status by Method	3	12.29	4.10	2.19	0.089

Table D.11
Analysis of variance for overall quality score of mashed potatoes according to preparation method and patient status

Source	D.F.	SS	MS	F Ratio	F Prob.
Within Cells	399	757.03	1.90		
Method	3	3.76	1.25	0.66	0.577
Status by Method	3	3.11	1.04	0.55	0.651

Table D.12
Analysis of variance for flavor score of mashed potatoes according to gender

Source	D.F.	SS	MS	F Ratio	F Prob.
Within Cells	133	766.40	5.76		
Gender	1	2.57	2.57	0.45	0.506

Table D.13
Analysis of variance for texture score of mashed potatoes according to gender

Source	D.F.	SS	MS	F Ratio	F Prob.
Within Cells	133	711.21	5.35		
Gender	1	4.77	4.77	0.89	0.347

Table D.14
Analysis of variance for overall quality score of mashed potatoes according to gender

Source	D.F.	SS	MS	F Ratio	F Prob.
Within Cells	133	707.66	5.32		
Gender	1	4.27	4.27	0.80	0.372

Table D.15
Analysis of variance for flavor score of mashed potatoes according to age

Source	D.F.	SS	MS	F Ratio	F Prob.
Within Cells	127	696.99	5.49		
Age	7	71.98	10.28	1.87	0.079

Table D.16
Analysis of variance for texture score of mashed potatoes according to age

Source	D.F.	SS	MS	F Ratio	F Prob.
Within Cells	127	686.95	5.41		
Age	7	29.03	4.15	0.77	0.616

Table D.17
Analysis of variance for overall quality score of mashed potatoes according to age

Source	D.F.	SS	MS	F Ratio	F Prob.
Within Cells	127	669.03	5.27		
Age	7	42.91	6.13	1.16	0.328

Table D.18
Analysis of variance for flavor score of tomato sauce samples according to preparation method and patient status

Source	D.F.	SS	MS	F Ratio	F Prob.
Within Cells	134	232.86	1.74		
Method	1	18.67	18.67	10.74	0.001
Status by Method	1	.01	.01	.01	0.943

Table D.19
Analysis of variance for texture score of tomato sauce samples according to preparation method and patient status

Source	D.F.	SS	MS	F Ratio	F Prob.
Within Cells	134	162.37	1.21		
Method	1	7.51	7.51	6.19	0.014
Status by Method	1	.01	.01	.01	0.943

Table D.20
Analysis of variance for overall quality score of tomato sauce samples according to preparation method and patient status

Source	D.F.	SS	MS	F Ratio	F Prob.
Within Cells	134	182.45	1.36		
Method	1	21.19	21.19	15.56	0.000
Status by Method	1	.32	.32	.23	0.630

Table D.21
Analysis of variance for flavor score of tomato sauce samples according to gender

Source	D.F.	SS	MS	F Ratio	F Prob.
Within Cells	134	517.92	3.87		
Gender	1	0.96	0.96	0.25	0.619

Table D.22
Analysis of variance for texture score of tomato sauce samples according to gender

Source	D.F.	SS	MS	F Ratio	F Prob.
Within Cells	134	464.06	3.46		
Gender	1	0.26	0.26	0.08	0.784

Table D.23
Analysis of variance for overall quality score of tomato sauce samples according to gender

Source	D.F.	SS	MS	F Ratio	F Prob.
Within Cells	134	467.82	1.36		
Gender	1	2.17	2.17	0.62	0.432

Table D.24
Analysis of variance for flavor score of tomato sauce samples according to age

Source	D.F.	SS	MS	F Ratio	F Prob.
Within Cells	128	476.68	3.72		
Age	7	42.20	6.03	1.62	0.136

Table D.25
Analysis of variance for texture score of tomato sauce samples according to age

Source	D.F.	SS	MS	F Ratio	F Prob.
Within Cells	128	433.16	3.38		
Age	7	31.16	4.45	1.32	0.248

Table D.26
Analysis of variance for overall quality score of tomato sauce samples according to age

Source	D.F.	SS	MS	F Ratio	F Prob.
Within Cells	128	439.12	3.43		
Age	7	30.86	4.41	1.29	0.263