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Potassium Chloride as a Salt Substitute in Bread

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Western Michigan University
College of Education and Human Development
BS Dietetics

Potassium Chloride as a Salt Substitute in Bread

A Thesis submitted to

Lee Honors College

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Andrea Noud

I am a senior here at Western Michigan University enrolled in the Dietetics program. Per my major requirements, I was enrolled in a class called Advanced and Experimental Foods last fall. During this class, I investigated and observed various ingredients and their properties, and experimented with varying amounts of these ingredients. I documented changes in foods based on their ingredients, such as color, texture, visual appearance, volume, and taste. By doing this, it helped me gain an understanding of the physical and chemical properties of foods by using both objective and subjective testing methods.

For our final project, we were instructed to come up with an experiment of our own: to replace an ingredient in a food item with something else and observe and document the outcomes. For my group project, we chose to replace sodium chloride with potassium chloride in whole wheat bread. I will discuss the results of this project later in my thesis in greater detail, but the results were very appealing. With sodium consumption at an all-time high, and cardiovascular disease being the number one killer in America, we were very pleased to see that replacing sodium chloride with potassium chloride in whole wheat bread did not alter the taste, look, or texture of the bread.

After the class had finished, we decided to submit our work to the Academy of Nutrition and Dietetics for a chance to present our findings at the Michigan Academy of Nutrition and Dietetics Annual Spring Conference Poster Competition 2016. We were accepted, and ultimately placed second in the competition. This recognition only furthered my excitement and interest in sodium consumption. With bread being one of the saltiest foods in our diet, this project has helped prove that there are ways to reduce sodium in the American diet without compromising the way food looks or tastes to consumers.

Sodium is a colorless crystalline compound occurring naturally in many foods.¹ The most common place it is found is in sodium chloride, which is more commonly known as table salt. Sodium chloride consists of 40% sodium and 60% chloride by weight.² It is found naturally in milk as well as vegetables such as celery and beets. Drinking water contains varying amounts of sodium, depending on the source. Although too much salt can cause negative effects on the body, it is required for life. Salt performs various tasks within the body, such as regulating blood volume, blood pressure, and osmotic equilibrium and pH.³

Prior to refrigeration, ancient populations relied on salt to preserve their meat. This practice made salt an extremely precious commodity; it was even traded for gold. Even well into American history, salt was vital to our survival. During the Civil War, it was used not only for eating, but also for tanning leather, dyeing clothes, and preserving troop rations.⁴

Today, salt is still used as a seasoning and preservative in processed foods and is used in various forms such as sodium nitrite, sodium benzoate, monosodium glutamate (MSG), and sodium bicarbonate (baking soda). It is found in processed foods such as soy sauce, canned vegetables and soups, and processed meats like sausage, bacon, lunch meat, and practically anything that can be stored for a lengthy amount of time in our cupboards, refrigerators, and freezers.

Fast food is also extremely high in sodium.⁵ For example, a large French dip from Quizno's has a whopping 4,460 mg of sodium, three times the DRI!⁶ As lifestyles become more hectic and fast paced, fast food consumption has become a growing part of the American diet. During 2007–2010, adults consumed an average of 11.3% of their total daily calories from fast food.⁷ With such a large percentage of calories coming from fast food sources, it is easy to see how fast food plays such a significant role in the sodium intake of Americans.

The American Heart Association comprised a list of the “Salty Six”; the top six processed foods containing the most sodium chloride. The Salty Six includes bread, cold cuts of meat, pizza, processed poultry, canned soup, and sandwiches.⁸

Sodium is a very common ingredient in the American diet and has been determined to provide health problems for those with kidney disease, osteoporosis, and cardiovascular disease.⁹ The Dietary Guidelines Advisory committee (DGAC) found that overall, Americans do not tend to meet recommendations for vegetables, fruit, dairy, or whole grains, yet we exceed recommendations for sodium and saturated fat.¹⁰ A diet high in sodium has been associated with adverse outcomes in even the healthiest of populations. The related outcomes of stroke and heart failure including the incident for hypertension have increased as a result of over consumption of sodium. The DRI of sodium for healthy adults is 1.5 g/day and the tolerable upper intake is 2.3 g/day.

Dietary reference intake (DRI) guidelines are established by The Food and Nutrition Board of the Institute of Medicine. Per these values, children ages 9-13 should consume no more than 2.2 g/day of sodium, and men and women ages 14-70 and older should consume no more than 2.3 g/day.¹⁰ Yet the average intake of sodium in America is much higher than the DRI: 3.4 g/day. The American Heart Association as well as the Academy of Nutrition and Dietetics recommends decreasing sodium intake in order to prevent or better manage cardiovascular disease. Consuming less sodium can also aid in the prevention of kidney disease, osteoporosis, stomach cancer, and even headaches.^{11,12} Reducing sodium intake by 3 g/day is projected to reduce the number of new cases of coronary heart disease annually by 60,000 to 120,000, stroke by 32,000 to 66,000, and myocardial infarction by 54,000 to 99,000. It is also projected to reduce the annual number of deaths from any of the diseases mentioned previously by 44,000 to 92,000.

Not only is reducing sodium intake projected to reduce the prevalence of disease and disease-related deaths, it is also projected to save an estimated \$10-24 billion in healthcare costs annually.¹³

Sodium and water balance are important for all patients, but require specific attention for abnormalities found in patients with chronic kidney disease (CKD). When kidneys are not functioning properly, excess sodium and fluid build up inside the body, potentially resulting in swollen ankles, puffiness, high blood pressure, shortness of breath, and fluid congregating around the heart and lungs.¹⁴ One cohort study examined the association between sodium and patient characteristics, as well as the patient outcomes such as end stage renal disease (ESRD) and mortality. The results suggest that patients with CKD are at a higher risk for progression to ESRD and higher mortality with higher sodium levels. Patients with CKD with sodium abnormalities, should remain alert for the observed associations discussed previously.¹⁵ However, patients with CKD should consult with a doctor prior to changing their diet, as potassium levels may have different effects on patients with renal failure.

Osteoporosis is a medical condition in which the bones become brittle and fragile from loss of tissue, typically as a result of hormonal changes, or deficiency of calcium or vitamin D.¹⁶ Dietary sodium is a major determinant of urinary calcium loss. Consuming too much sodium results in competition between sodium and calcium for reabsorption in the kidneys. When 2.5 g of sodium chloride are excreted by the kidneys, it has been found to cause about 26.3 mg of calcium to be excreted into the urine.¹⁷ One study found that reduction in renal sodium reabsorption induced by high salt intake leads to decreased calcium resorption and loss of calcium. This increase in calcium excretion is accompanied by an increase in hydroxyproline

excretion, suggesting that there is increased bone resorption. High sodium intake leads to a reduction in bone mineral content, especially if dietary calcium is low.¹⁸

Two studies conducted in the 1980s, were key in increasing the public's awareness of the risks of sodium and hypertension. In one study, researchers measured the amount of sodium excreted over a 24-hour period. This study was conducted on more than 10,000 adults from 32 countries around the world. The average amount of sodium that was excreted was nearly 4,000 milligrams of sodium per day. However, the range was enormous, from only 200 milligrams a day among a group of people from Brazil to an astonishing 10,300 milligrams a day in northern Japan. The study found that populations with higher salt consumption had higher blood pressures on average and greater increases of blood pressures with age. Four groups of people (the four countries with salt intakes under 1,300 milligrams per day) had low average blood pressures and little or no upward trend of blood pressure with age.

Two Trials of Hypertension Prevention (TOHP) were conducted in the late 1980s and early 1990s. These studies tested the impact of lifestyle changes on blood pressure, such as weight loss, stress management, nutritional supplements, and consuming less sodium. In each of the studies, small decreases in blood pressure were seen with sodium reduction over the 18 to 36 months the trials lasted. Years after the trials had ended, the researchers performed follow-up surveys with the participants and found that after 10–15 years, the TOHP participants in the sodium-reduction groups were 25 percent less likely to have had a heart attack or stroke, to have needed a procedure to open or bypass a cholesterol-clogged coronary artery, or to have died of cardiovascular disease. They also found that the higher the ratio of potassium to sodium in a participant's diet, the lower the chances were of developing cardiovascular trouble. This research

suggests that a strategy that includes both increasing potassium and lowering sodium may be the most effective way to fight high blood pressure.¹⁹

Another more recent study was conducted to determine the association between urinary sodium and potassium excretion and risk of cardiovascular events. This randomized control trial compared the effects in patients with established cardiovascular disease or diabetes mellitus. The study found that there is a higher association between higher estimated potassium excretion and reduction in stroke risk. From a number of DASH trials and from the Trials of Hypertension Prevention Collaborative Research Group found, “that by reducing sodium excretion and targeting levels consistent with current guidelines, blood pressure was reduced in those with and without hypertension”.²⁰ This study reports that there is an association between estimated urinary sodium excretion and cardiovascular events in patients with increased risk for cardiovascular disease. There were also associations between high sodium excretion and cardiovascular events, and likewise, an association between low sodium excretion and cardiovascular deaths. Sodium has many adverse effects on cardiovascular disease, however, there are several effects of potassium replacers as well. The study concluded that “higher urinary potassium excretion was associated with lower stroke risk and is a potential intervention that merits further evaluation for stroke prevention”.²¹ Therefore a potential preventative measure for cardiovascular disease is replacing part of one’s dietary sodium chloride with potassium chloride.

As mentioned previously, one possible substitute for sodium chloride is potassium chloride, as it has similar antimicrobial effects and function. Maleki et al conducted a study on the flavor and acceptability of various potassium-enriched salts and found that when the concentration of potassium was low, most of the participants could not distinguish between the

salts. They also found that the number of participants who preferred potassium-enriched salt was greater than those who preferred pure sodium chloride in all concentrations but 10% (0%, 5%, 10%, 15%, 20%, 25%, and 30% potassium chloride concentrations were tested).²² Potassium is a mineral that the body uses to control blood pressure as it counteracts with sodium. Potassium aids in relaxing blood vessel walls, which in turn decreases blood pressure; potassium decreases intravascular volume, partly through increased urinary sodium excretion. It also contributes to alterations in baroreflex sensitivity and sensitivity to receptors and hormones that control vascular smooth muscle and sympathetic nervous system cell function. These effects may be important in lowering blood pressure and decreasing sodium reabsorption.

The RDI for potassium for healthy adults is 4,700 mg/day. Many foods contain potassium. Good sources of potassium include meat and soy products, broccoli, peas, lima beans, tomatoes, potatoes and their skins, sweet potatoes, winter squash, citrus fruits, cantaloupe, bananas, kiwi, prunes, and apricots, with dried apricots containing more potassium than fresh apricots. Milk, yogurt, and nuts are also excellent sources of potassium.²³ These foods play a significant role in lowering blood pressure in both hypertensive and normotensive people. The organic potassium salts in foods have a broad range of health benefits to the heart, kidney, bone, and other tissues.²⁴ People with kidney problems, especially those on dialysis, should not eat too many potassium-rich foods, as it could have a negative effect on their illness. Those with kidney problems should consult with their health care provider prior to making any dietary changes.²³

Most Americans do not get anywhere near the recommended amount, with men and women only getting 3,200 mg/day and 2,400 mg/day, respectively.²⁴ Potassium is a nutrient that is not typically found in fortified foods or commonly consumed as a dietary supplement. It is one of the four major shortfall nutrients in the American diet per the 2010 DGAC. This level of

intake is difficult for most Americans to achieve as only 3 percent met this level in the 2003-2006 National Health and Nutrition Examination Survey (NHANES) representative sample.

Having too much or too little potassium in the diet can impact our health. Low levels of potassium can lead to hypokalemia, which can cause weak muscles, abnormal heart rhythms, and a rise in blood pressure. Those who take diuretics or laxatives regularly may develop hypokalemia, as well as those who have severe and/or prolonged vomiting and diarrhea, or those who have certain kidney or adrenal gland disorders are at risk for developing hypokalemia.

High levels of potassium in the blood is known as hyperkalemia. It has the ability to cause abnormal and dangerous heart rhythms. Common causes of hyperkalemia include poor kidney function, angiotensin converting enzyme inhibitors and angiotensin 2 receptor blockers (heart medications), potassium-sparing diuretics, and severe infection.²³

A randomized crossover trial conducted at Deakin University in Burwood, Australia, demonstrated that reducing sodium and increasing potassium intake decreased blood pressure measurements. The study consisted of 108 participants, sixteen of which were hypertensive and taking antihypertensive medication. Participants were instructed to follow a low sodium, high potassium self-selected diet for eight weeks. They were given either a placebo tablet or a slow release sodium tablet for four weeks, and then switched to the alternative tablet for the remaining four weeks. Results of the study showed that following the low sodium / high potassium diet lowered blood pressure for all participants by 3.3 +/- 1.0 mmHg.²⁴

One way that we can potentially cause a significant decrease in sodium consumption is through bread consumption. Bread is a staple product in the diet of most consumers in America. With each slice containing anywhere from 80-230 mg of sodium, and the average American consuming around 53 loaves of bread per year, it's not hard to see why reducing sodium in bread

would be beneficial to the health of the general population.²⁵ Unfortunately, salt plays a significant role in the baking process, so it cannot be completely removed. One option for reducing the sodium chloride content in bread products is by partial replacement with potassium chloride. One study found that replacing 50% or less of sodium chloride with potassium chloride had no adverse effects on dough rheology, although it did have a slightly bitter or metallic aftertaste. This taste became more noticeable as the percentage of potassium chloride was increased in the product.^{25,26} Another study performed by Wyatt and Ronan did not find any significant differences between the control product (100% sodium chloride) and the 50:50 ratio breads. The bread found to have the highest acceptability among panelists was one with 75:25% sodium chloride/potassium chloride ratio.²⁷

As I mentioned in the beginning of my thesis, I performed my own experiment by replacing sodium chloride with potassium chloride in whole wheat bread. The objective of this study was to determine whether or not there were noticeable differences between bread made with 100% sodium chloride and bread made with a percentage of potassium chloride in place of sodium chloride, and to determine if bread made with potassium chloride could be accepted by consumers. Objective and subjective tests were performed on three variations of whole wheat bread with varying amounts of sodium chloride and potassium chloride as a substitute in order to determine differences in appearance, volume, and sensory characteristics. We modeled our ratio's off the study performed by Wyatt and Ronan mentioned in the previous paragraph. The control product contained 100% sodium chloride. There were two loaves that partially substituted sodium chloride with potassium chloride: one with 25% potassium chloride, and another with 50% potassium chloride. Objective tests were performed to analyze samples for crust color, contour of surface, crumb color, cell size, thickness of cell walls, and volume. A nutrient analysis was also performed

on each loaf which shows sodium and potassium content as well as other major nutrients. Subjective tests included a descriptive hedonic test for appearance, flavor, texture, and moistness, as well as two paired comparison tests for bitterness and saltiness. The 50% potassium chloride variation was found to be the most bitter, and the control was found to be the saltiest. Overall, panelists preferred the 25% potassium chloride variation over both the 50% potassium chloride variation and the control. This information suggests that bread made with potassium chloride could be marketed to consumers without any noticeable differences in appearance or taste, thereby aiding in the reduction of sodium intake through bread consumption. The purpose of this study was to analyze differences in appearance, volume, sensory attributes, and overall consumer preference of the three different whole wheat breads containing various amounts of Sodium chloride and Potassium chloride.

Three bread variations were compared: 100% sodium chloride (control), 25% potassium chloride, and 50% potassium chloride. Samples were prepared using a basic bread recipe that included three cups of whole wheat flour, 1.5 tsp of instant yeast, 1.5 tsp (10 g) of salt, 1.5 tbsp of white sugar, 1.5 tbsp of dry nonfat milk powder, 1.5 tbsp of butter, and 1.25 cups of water. All dry ingredients were sifted together in a large bowl and set aside. The water and dry nonfat milk powder were combined and scalded prior to mixing with dry ingredients in order to deactivate the whey protein and prevent it from interfering with the yeast. Butter was added to the scalded milk as it was cooling down to 110°F. The milk was cooled to this temperature to ensure that the yeast would not be damaged. All loaves were allowed to rise for one hour at room temperature and baked at 350°F for 30 minutes. To create the sample containing 25% potassium chloride, 2.5 g of potassium chloride and 7.5 g of sodium chloride were added instead of the full 10 g of sodium chloride that the recipe originally called for. To create the sample containing 50% potassium

chloride, 5 g of potassium chloride and 5 g of sodium chloride were added instead of the full 10 g of sodium chloride that the recipe called for. All loaves were allowed to cool for 2 hours prior to cutting.

Sensory tests were performed on fifteen untrained students at Western Michigan University. Three subjective tests were performed to collect data relating to flavor, appearance, texture, and moistness. Two paired comparison tests were performed: one for saltiness, and one for bitterness. Panelists were asked to taste the three samples, rinsing their mouth in between samples, and choosing which sample was the most bitter and which sample was the saltiest. A descriptive hedonic test was performed for appearance, flavor, texture, and moistness. Panelists were asked to rate the samples on a scale from 1-9, with 1 being “dislike extremely”, and 9 being “like extremely”.¹⁰ Panelists were also asked to state which sample they preferred overall. Objective tests were performed to analyze samples for crust color, contour of surface, crumb color, cell size, thickness of cell walls, nutrients, and cooked volume. The volume of the bread was measured using a volumeter in the food lab in Kehrman Hall, located on the campus of Western Michigan University.

A nutrient analysis was performed on all loaves and results are summarized in Table I. The control had 260 mg of sodium per serving; roughly 17% of the DRI. The 25% potassium chloride variation had 198 mg of sodium; roughly 13% of the DRI. The 50% potassium chloride variation had 138 mg of sodium; roughly 9% of the DRI. The 25% potassium chloride variation also had 108.6 mg of potassium per serving; about 3% of the DRI. The 50% potassium chloride variation had 217.3 mg; roughly 6% of the DRI.

Table I : Nutrient Analysis of Bread Variations

Nutrients Per Serving	Control	25% Potassium chloride	50% Potassium chloride
Calories	120 kcal	120 kcal	120 kcal
Fat	3 g	3 g	3 g
Sugar	2 g	2 g	2 g
Carbohydrates	23 g	23 g	23 g
Protein	4 g	4 g	4 g
Sodium	260 mg	198 mg	138 mg
Potassium	0 mg	108.6 mg	217.3 mg

Objective tests were performed on all loaves and are summarized in Table II. The 25% potassium chloride variation had a darker external appearance than the control, while the 50% potassium chloride variation was lighter than the control. It is possible that this difference in color could be due to oven placement while cooking, which could cause an uneven distribution of heat. The surface contour varied greatly per loaf, which could be due to varying kneading techniques used by myself and my group members at the time. Crumb color, cell size, and thickness of cell walls of the 25% potassium chloride variation was identical to the control. The 50% potassium chloride variation had a darker interior appearance than the control, with a smoother surface and larger cell sizes.

A volume test was performed using a volumeter, which determines product size by measuring seed displacement. Basically what happens is the loaf of bread is inserted into the

volumeter, release a lever, and seeds fall down into the bottom of the machine. This then provides a reading of the actual volume of the loaf of bread. The 50% variation was the largest at 700 cc, followed by the control at 567 cc, and the 25% variation at 450 cc. Sodium is known to retard gluten development, therefore it was expected that both the 25% and the 50% variations would have a larger volume than the control.¹⁰ While the 50% variation was the largest as expected, the 25% variation ended up being the smallest, which is more than likely due to inadequate rising time or potentially insufficient kneading. This is why it is extremely important to have a set of guidelines established when performing this type of experiment in order to ensure uniformity of production.

Table II: Objective Testing

	Control	25%	50%
External Appearance: Crust Color	- Golden brown - Lighter than 50% variation	- Darker than control - Darker in the middle, lighter along edges	-Brownish tan - Lighter than control
Contour of Surface	- Slightly bumpy	- Very bumpy compared to control	- Fairly smooth surface
Crumb Color	- Light tan	- Light tan, no difference from control	- Tiny bit darker than control
Internal Appearance: Cell Size	- Both small and large cells - More small than large cells	- Same as control	- Larger cell sizes than control
Thickness of Cell Walls	- medium thickness of cell walls	- same as control	- Thicker cell walls than control
Volume	567 cc	450 cc	700 cc

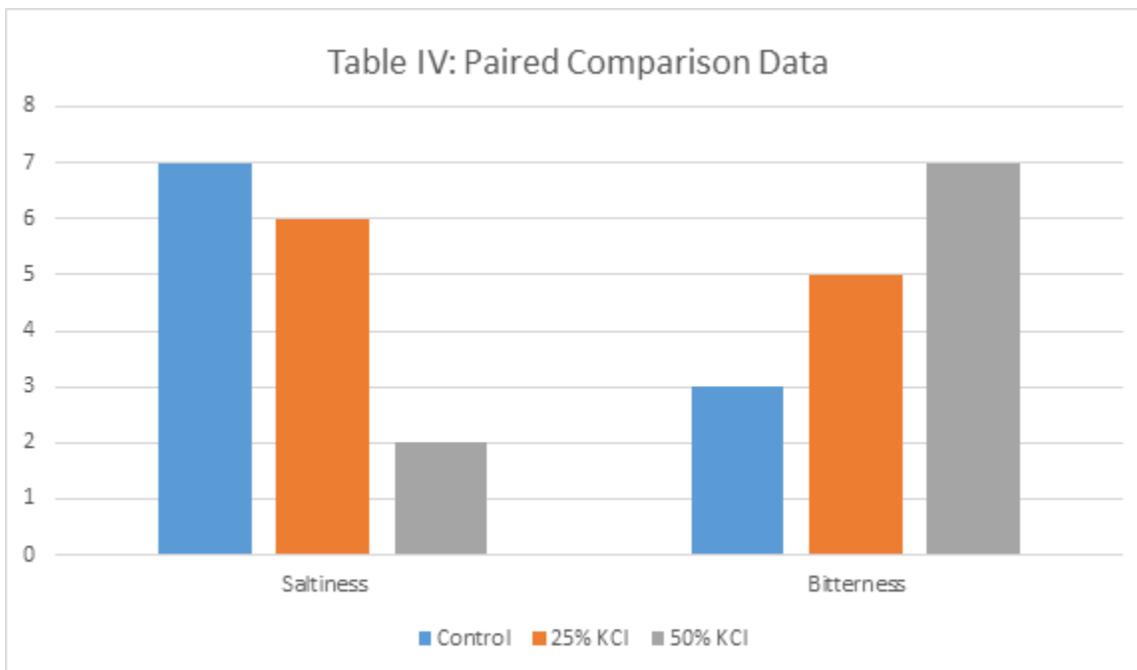
A descriptive hedonic test was performed to evaluate appearance, texture, flavor, and moistness, and results are summarized in table III. Samples were rated between 1 and 9 with the following descriptions for all characteristics: 1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = Like moderately, 8 = Like very much, 9 = Like extremely. The control scored identical to the 50% variation on appearance and almost identical on flavor. The 50% variations scored slightly higher than the control on flavor and moistness. The 25% variation scored the highest for all characteristics. Panelists did not prefer the control in any of the categories, which implies that bread made with potassium chloride could be marketed to consumers without any noticeable differences in appearance, flavor, texture, or moistness.

Table III: Descriptive Hedonic Test Summary

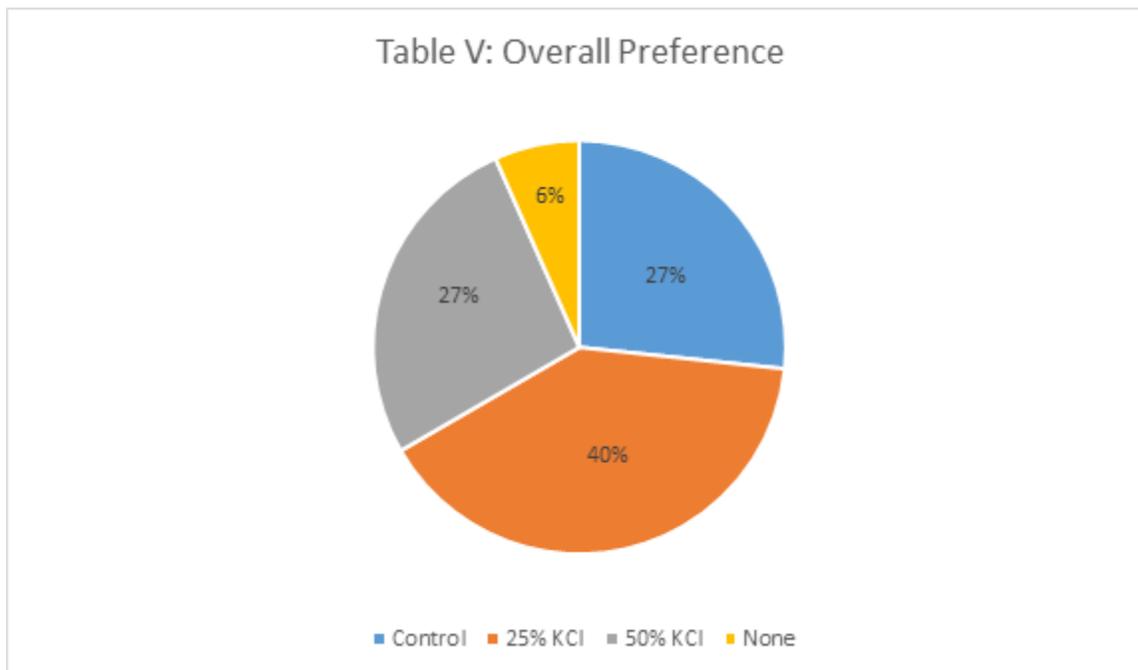
Characteristic	Control	25% Potassium chloride	50% Potassium chloride
Appearance	6.2	6.9	6.2
Flavor	4.9	5.7	5.0
Texture	5.4	6.4	5.8
Moistness	5.2	6.1	5.5

Scale: 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

Two paired comparison tests were performed for saltiness and bitterness and results are summarized in table IV. 47% of panelists determined that the control was the saltiest. 40% stated that the 25% variation was the saltiest, and 13% of the panelists stated the 50% variation was the saltiest. The 50% variation scored the lowest for saltiness, which was expected due to it having the least amount of sodium chloride present. According to the bitterness paired comparison test, 20% of the panelists determined that the control was the most bitter, 33% stated that the 25% potassium chloride variation was the most bitter, and 47% determined that the 50% potassium chloride variation was the most bitter. This was expected due to the 50% variation containing the highest amount of potassium chloride, which is known for having a metallic or bitter aftertaste when consumed in large quantities. These results coincide with a similar study that found that replacing 50% or more of sodium chloride with potassium chloride gave a slightly bitter or metallic aftertaste. The taste became more noticeable as the percentage of potassium chloride was increased.¹¹



Panelists were instructed to state their overall preference and results are shown in table V. Panelists equally preferred the control and the 50% potassium chloride variation. 40% of panelists preferred the 25% potassium chloride variation. Outliers included in the test results indicated that 6% (one participant) of the panelists did not prefer any of the variations. This data coincides with a previous study that determined that the bread found to have the highest acceptability among panelists was one with 75:25% sodium chloride/potassium chloride ratio.³⁰



Overall, panelists that participated in our research preferred the 25% potassium chloride variation over the 50% potassium chloride and the control. According to the data collected, potassium chloride can be substituted for sodium chloride in whole wheat bread without any noticeable differences in appearance, flavor, texture, or moistness. A larger percentage of potassium chloride resulted in a larger loaf; however, increasing the percentage of potassium

chloride did cause a slightly bitter aftertaste as expected. These results coincide with data collected in a previous study where panelists preferred bread made with a 75:25% sodium chloride/potassium chloride ratio.³⁰ Due to panelists not preferring the control product over bread containing potassium chloride substitutions, it is possible for bread containing potassium chloride to be marketed to consumers, and potentially reducing sodium intake through bread consumption.

DRI guidelines are established by The Food and Nutrition Board of the Institute of Medicine. Per these values, children ages 9-13 should consume no more than 2.2 g/day of sodium, and men and women ages 14-70 and older should consume no more than 2.3 g/day.⁵ Yet the average intake of sodium in America is much higher than the DRI: 3.4 g/day. The American Heart Association as well as the Academy of Nutrition and Dietetics recommends decreasing sodium intake in order to prevent or better manage cardiovascular disease. Consuming less sodium can also aid in the prevention of kidney disease, osteoporosis, stomach cancer, and even headaches.^{6,7}

Some companies have taken the initiative to reduce sodium content in their products on their own. Nestlé has removed roughly 7,500 tons of sodium from their products since 2005. Knorr dry soups has reduced their sodium content by 10%, and Kellogg's has reduced sodium content of many of their cereals by 38% over the last decade. While salt is necessary in terms of food preservation and other aspects of food production, it is possible to make reductions in the quantity of salt used without other measures being put into place (such as in the production of bread).²

However, it all boils down to money, and it has been estimated that reducing sodium content by 20-30% would increase food cost by 5-30% depending on the type of food. However, a data analysis indicated that investing 25.5 million dollars on salt reduction efforts could

prevent 6,000 deaths due to cardiovascular disease. This would in turn lead to a savings of 500 million dollars per year, proving that the health and economic benefits of salt reduction in packaged foods would outweigh the cost of recipe reformulation.²

The best and most efficient way to reduce sodium content in pre-packaged and processed food is to put pressure on the food industry to expand its efforts in reducing the sodium content of foods. The human salt taste receptors can adapt over time to lower salt concentrations, making small sodium reductions in processed foods (accomplished in a step by step manner rather than all at once) a way to reduce sodium without the reduction being detected by consumers. It is also imperative that we help consumers understand how to flavor unsalted foods with spices and herbs. Reducing sodium can be accomplished simply by eating a healthy diet, which some consumers are aware of, but others may need a little guidance and a push in the right direction. Policies and programs at local, state, and national levels are essential to support reduction efforts. In addition to reducing sodium in processed and pre-packaged foods, labeling of food products needs to improve in order to increase consumer awareness and understanding of sodium in food.⁸

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