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Article

An Investigation into Strategies for Using Chopped Onion and Grated Fresh Cassava in Reducing Cooking Time of Dry Beans

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Abstract: This study was conducted with beans to determine a protocol that will help reduce the cooking time of beans. It was carried out in the Foods laboratory at the University for Development Studies, Department of Family and Consumer Sciences. A quasi-experimental design was the design tool employed for this study to establish a cause-and-effect relationship between an independent and dependent variable where the independent variable is cooking time and dependent variable is softness of the beans. An experiment was carried out to text the effect of 2 different treatments given to beans during cooking to ascertain which treatment is best for reducing the cooking time for bean. The treatments meted out were addition of blended onion, crushed cassava and no additives. Addition of blended onion had a very significant effect in reducing cooking time with cooking time of 43minutes. Cooking beans with crushed cassava also saw some reduction in the cooking time for beans with 46 minutes. Cooking dry beans with no additive having the highest cooking time (47minutes). With quantity of water, the dry beans sample with crushed cassava used more quantity of water (3.4 liters). Cooking with blended onion and with no treatment both used 2.9 litres per 100grams beans each. The study therefore recommends that crushed onions are added to help reduce the cooking time of dry beans.

Keywords: Cooking Beans, Chopped Onion, Grated Fresh Cassava, Cooking Time

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1. Introduction

Legumes are plants belonging to the family Leguminosae also called as Fabaceae that produce seeds within a pod [1]. Leguminosae is a large family with over 18,000 species of climbers, herbs, shrubs and trees of which only a limited number is used as human food. Common legumes used for human consumption include peas, broad beans, lentils, soybeans, lupins, lotus, sprouts, mung bean, green beans, black eye beans (common beans) and peanuts and are referred to as grain legumes or food legumes [2]. Food legumes are divided into two groups, namely oil seeds and pulses. The former being legumes with high oil content such as soybean and peanuts and the latter being all dry seeds of cultivated legumes used as traditional food [3]. Legumes are believed to be one of the first crops cultivated by mankind and have remained a staple food for many cultures all over the world [2]. These seeds are valued worldwide as an inexpensive meat alternative and are considered the second most important food source after cereals [2]. Legumes are nutritionally valuable, providing proteins with essential amino acids, complex carbohydrates, dietary fibre, unsaturated fats, vitaminutes and essential minerals for the human diet [4]. Legumes have also been ascribed economic, cultural, physiological and medicinal roles owing to their possession of beneficial bioactive compounds. The consumption of legumes has also been reported to be associated with numerous beneficial health attributes such as hypocholesterolemic, antiatherogenic, anticarcinogenic and hypoglycemic properties [5, 6]. Legumes have proven to be a cheap

source of nutrients as well as a potential source of income for subsistence farmers who cultivate legumes at household level.

It is of utmost importance to increase the utilization of legumes and to introduce new legume-based products that will be affordable to low-income groups as a way to reduce poverty and alleviate malnutrition, this will go a long way to reduce food insecurity. Protein-energy malnutrition (PEM) is a major nutritional syndrome affecting over 170 million preschool children and lactating women in developing African and Asian countries [7]. The prevalence of PEM can be attributed to many factors such as the high price of animal protein (eggs, meat and milk), the staple cereal-based diet and the ever increasing price of food commodities becoming unaffordable to the lower income groups to mention a few. Although high-protein legumes such as soybean and cowpea are available to consumers, their consumption rate surpasses their production rate; thus, an ever-increasing demand has been observed [8].

Cooking beans is a fundamental preparation step of beans for consumption that is aimed at achieving palatability coupled with increased digestibility of nutrients, reduction/elimination of anti-nutrients, and improved sensorial attributes such as aroma, taste, and texture [9]. Additionally, cooking inactivates hemaglutinin, a protein that has been shown to be able to bind to carbohydrates on the surface of cellular membranes such as red blood cells thus causing toxicity [10]. Several methods of cooking beans involve the use of dry or wet heat, with the (out) application of pressure, the addition of chemicals, and (not) preceded by soaking and exploitation [11]. There are no standardized cooking protocols of beans and the few guidelines available vary depending on market class or bean variety. In the absence of a validated cooking procedure, the determinant for the use of a particular cooking method often is affordability and convenience in terms of time and energy costs without considering any nutritional consequences. Shorter cooking times allow a considerable reduction in energy consumption [12]. Moreover, with the trend in increased urbanization, a factor such as convenience has become an important driver of food choice [13].

Although cooking is paramount to achieving nutritional benefits, prolonged exposure to high temperatures may be detrimental to some nutrients present in beans [14]. This is attributed to either leaching out of nutrients, the degradation of compounds such as vitamins and amino acids, and/or due to heat-induced crosslinking reactions that lead to the formation of insoluble complexes that limit the digestibility of the nutrients involved [15]. Cooking beans is, therefore, an intricate balance between enhancing textural attributes and reduction of anti-nutrients and toxic compounds while ensuring maximum retention of nutrients. Investigation into protocols that can reduce the preparation and cooking time of beans becomes essential against this background.

Beans are among the most versatile and commonly eaten foods throughout the world, and many varieties are grown in Ghana. Because of their nutritional composition, beans have the potential to improve the diet quality and long-term health of those who consume regularly. It is also beneficial for low-income earners who may not be able to afford animal protein which is on the expensive side for them. Many homes in Ghana may eat beans once in a while because they consider cooking beans as energy-consuming. The cost of fuel becomes a burden for them even if they are able to afford the cost of beans. Notwithstanding its availability, most homemakers due to the long time it takes for beans to get cooked will not choose and prepare beans as part of meals to feed the family. Homemakers who do not have much food preparation time find it burdensome to include beans in the diet of their families. This will go a long way to affect the protein intake of especially low-income earners making them susceptible to PEM. A casual study conducted showed that women in low-income families in the quest to provide other needs aside from food, spend most of their time working outside the home to get income to support home, this makes time a very important factor when it comes to providing meals for the family. Many women in this category will choose and cook dishes that are not time-

consuming or may even opt for their children to be eating low-nutrient food from the streets. Making beans an unfavorable ingredient to choose for meals. It, therefore, becomes important that experiments be carried out on the cooking strategies that can be employed to shorten the cooking time for beans so as to encourage families to choose and consume beans. The purpose of this study was to examine strategies for cooking beans, with the addition of chopped onion, and grated fresh cassava for reducing cooking time. The study was guided by these research objectives (1) Investigate the time used for cooking beans when chopped onions and grated fresh cassava are added (2) Compare the addition of chopped onion, and grated fresh cassava as a strategy for reducing the cooking time of beans.

1.1. Beans

The terms dry beans and legumes are often used interchangeably in the United States. In other parts of the world, including Canada, beans are often called pulses. Distinguishable by their seed-bearing pods, legumes are a family of plants characterized by 2 classes: oilseeds, such as soybeans and peanuts, and grain legumes, including dry beans, lima beans, cowpeas, fava beans, chickpeas (garbanzo beans), lentils, and dry peas. Of the estimated 16,000 legume varieties, more than 100 are cultivated commonly worldwide. Rooted from the Latin word puls, or ancient bean porridge, dry beans, peas, and lentils all qualify as pulses, but the term excludes green beans, green peas, soybeans, and peanuts [16]. (For the purpose of this research, ''beans'' refers to dry edible beans but excludes soybeans and all ''garden-type'' fresh-bean varieties green, string, wax, etc.) Legume. A family of plants with seed-bearing pods. These grain legumes include dry beans, lentils, dry peas, lima beans, and chickpeas. Pulse. A term used in many countries to refer to crops harvested solely for their grain, including dry beans, peas, and lentils but excluding green beans, green peas, soybeans, and peanuts.

Because they are easy to plant, grow, and store, beans are among the oldest cultivated and most widely used foods in the world. They also are relatively inexpensive to produce, are portable, and have a long storage life. Their low cost and high nutritional value have contributed to their global popularity. Historically, beans have served as a food staple for at least 10,000 years and some food historians double that figure. Today, beans continue to serve as food staples in China, India, the Middle East, and the Americas. Several varieties may have arrived in North America with the pilgrims on the Mayflower, but many others were native plants in North America [17]. Domesticated about 7,000 years ago in what is now Peru and Southern Mexico, several varieties of beans were already flourishing by the time the Portuguese and Spaniards arrived in the New World. Beans cultivation was diverse in the new world but the earliest cultivation was seen in both in South and North America. The main bean species cultivated from the New World is the common bean (Phaseolus vulgaris). Other New species from the new world include runner beans (Phaseolus coccineus), Lima beans (Phaseolus limensis), butter beans (Phaseolus lunatus) and tepary beans (Phaseolus acutifolius, var. latifolius). Beans became popular throughout Europe, Asia, and Africa which are the new worlds during the beginning of the 18th century [18].

1.2. Cooking Time for Beans

Legumes, such as beans and lentils, are nutritional superstars packed with protein, fiber, minerals, and B vitamins. But in order to reap their nutritional benefits, beans must be cooked thoroughly, either in a pressure cooker or a regular pot. If you are often in a hurry, buying a pressure cooker may be a good idea as it can shorten the cooking times of beans and other foods dramatically (in some cases by up to 70 percent). The option of purchasing a pressure cooker is not ideal for most homemakers in low and middle-income earning families because it is expensive to purchase and use.

The simmering times shown in Table 1, should be straightforward. Put the beans in a large pot, and cover with water by about an inch (add more water later, if necessary). Bring the pot to a gentle boil and let the beans cook uncovered, or with the lid on but slightly ajar. Do not add salt to the cooking water in the beginning as it can prevent the beans from absorbing water.

The pressure-cooking times in Table .1, are ideal for pressure cookers that operate at 15 PSI (Pounds per Square Inch). In many machines, 15 PSI is the standard pressure you get if you select the "high pressure" option. However, there are also many cookers that have been programmed to operate at 10 or 13 PSI when the "high" program is selected, so be sure to check the user manual before using your cooker. If the instruction booklet also has a chart of the recommended cooking times for legumes, it is a good idea to use that as a general guide (rather than the chart below) as ideal pressure-cooking times can vary significantly from machine to machine. When using a pressure cooker, the recommended water-to-beans ratio is 3 cups for each cup of soaked beans.

However, as legumes tend to expand and froth during cooking, you should make sure you never fill your pressure cooker to more than half of its capacity (counting both soaked beans and water). Table 1 shows the approximate cooking times for different types of beans, peas, and peas. The chart provides both pressure cooking times and simmering times (in a regular pot on the stove). Unless otherwise indicated, the times are for pre-soaked legumes. It is also possible to cook un-soaked beans in a pressure cooker, but this will prolong the cooking time significantly. Compared with their soaked counterparts, un-soaked beans also form more foam when heated, which in turn may block the vent pipe of your pressure cooker. Also from a health point of view, it makes sense to use soaked beans; soaking helps break down the sugars that are responsible for the gas-producing effects of beans and peas.

Pressure cooking saves time and has high efficiency in cooking beans. However, pressure cooking could be very expensive for low-income earners because of energy use. The cost of energy can be unbearable, especially for poor people in rural communities. It is most likely that domestic energy prices increase in Ghana and many more developing countries [19]. Consequently, irregular or unavailability of power in most deprived communities in developing countries presents challenges in relying on electric devices. The initial cost of acquiring a pressure cooker is also expensive and a detriment to low-income earners to purchase and use.

1.3. Treatments Given to Beans Prior to Cooking

Dry beans offer nutrition, health and economic benefits. However, you need to follow certain steps to ensure dry beans are cooked properly. The four basic steps are

Clean → *Rinse* → *Soak* → *Cook*

The first two steps simply involve removing any broken beans or foreign objects from beans and then rinsing them in a colander under cold running water [20].

1.3.1. Soaking Beans

The three different soaking methods vary in the amount of time required for adequate soaking. The “hot soak” method typically is recommended because it reduces cooking time and gas-producing compounds the most while consistently yielding tender beans. Soaking beans allows the dried beans to absorb water, which begins to dissolve the starches that cause intestinal discomfort. While beans are soaking, they are also doubling to tripling in their size [21].

Hot Soak: In a large pot, add 10 cups of water for each pound (2 cups) of dry beans. Heat to boiling; boil for 2–3 minutes. Remove from heat, cover, and soak for up to 4 hours.

Hot soaking is the preferred method since it reduces cooking time, helps dissolve some of the gas-causing substances in beans, and most consistently produces tender beans [20]

Quick Soak: This is the fastest method. In a large pot, add 6 cups of water for each pound (2 cups) of dry beans. Heat to boiling; boil for 2–3 minutes. Remove from heat, cover and soak for at least 1 hour (Mitchell et al., 2009).

Traditional Overnight Soak: This is the easiest method. Place dry beans in a large container; for each pound (2 cups) beans, add 10 cups of cold water. Cover and refrigerate 8 hours or overnight.

Drain and rinse beans soaked by either method with fresh, cool water before cooking [20].

Table 1. Cooking time for different types of beans

Beans Type	Pressure Cooking Time (Minutes)	Regular Cooking Time (Minutes)
Adzuki	5-9	35-45
Anasazi (Appaloosa)	8-10	60-90
Black (Turtle)	7-8	15-25
Borlotti	8-12	60-90
Cannellini	7-12	90-120
Flageolets	8-12	45-60
Great Northern	8-12	50-70
Kidney	8-12	50-90
Lima	8-12	50-70
Marrow	8-12	60-90
Mature Fava (Broad)	8-11	50-70
Mung	6-8	50-70
Navy	7-9	45-60
Orca	8-10	60-90
Pink Beans	8-10	50-70
Pinto	5-7	90
Rattlesnake Bean	5-8	40-45
Red Scarlet	10-12	50-70
Soybeans	12-20	180
White Beans	7-8	15-20

1.4. Cooking Beans

Cooking the beans makes them edible and digestible. Use cooked beans in your favorite recipes or refrigerate beans in shallow containers if they are to be eaten later freeze any extra beans within 4 days after cooking them. Beans can be cooked by using a stovetop or a multi-cooker/pressure cooker [23].

Stovetop Instructions: Place beans in a large pot; cover with fresh water and bring to a boil.

Reduce heat, cover, and simmer gently until beans are tender but firm. Most beans will cook in 45 minutes to 2 hours depending on the variety. Periodically, try a taste test or mash a bean against the side of the pot with a fork or spoon. Check occasionally if you need to add more water [23].

Multi-cooker/Pressure Cooker Instructions: Place beans in the pressure cooker; cover beans with about 4 cups of fresh water. Make sure there is about 2 inches of water above the beans. Seal the pressure cooker and cook according to the manufacturer's instructions. Adjust cooking times as needed depending on the variety. Cooking longer will result in

softer beans. Beans should be tender but not mushy. Allow 20 minutes for natural pressure release after cooking. If beans are not quite tender, cook them again on high pressure for 10 minutes and then quick release the pressure.

Drain immediately [23].

1.5. Nutrient Content

Beans contribute a number of important micronutrients to diets. According to NHANES 1999–2002 data, relative to non-consumers, those in the fourth bean intake quartile (mean intake: 277.1 g/d) consumed 31%, 22%, 13%, and 12% more folate, iron, zinc, and magnesium, respectively (Food and Agricultural Organization of the United Nations,2013). Beans are also rich in potassium, a mineral identified as a nutrient of concern by the Dietary Guidelines for Americans (DGAC) US adult men and women consume only approximately two-thirds and one-half of the Recommended Dietary Allowance (RDA) for this nutrient, respectively [24]. One serving of beans contains between 300 and 400 mg of potassium, which is similar to that provided by one serving of cow milk. Interestingly, the DGAC noted that it would be difficult to reach the recommended potassium intake without 3 daily servings of dairy, a conclusion that reflects the degree to which beans are not commonly consumed in the United States because they were not given a similar mention [25].

Beans are unique among protein-rich foods for their high carbohydrate and low-fat content. Approximately 3% of kilocalories in beans derive from fat, most of which is unsaturated. Chickpeas are an exception, providing ~15% of energy as fat. On a caloric basis, the protein content of beans is generally between 20% and 30%. A serving of beans (~90 g or 0.5 cup cooked beans) provides 7–8 g of protein. However, it is the indispensable amino acid lysine rather than the total protein content of beans that is a more important consideration for people consuming plant-based diets. Diets based on plant foods may fall short of meeting lysine needs if beans or other legumes (peanuts or soy) are not included in menus. One-half cup of beans provides only ~16% of the total protein requirement for a 60-kg person but 25% of the total lysine requirement. The lysine content of beans is especially notable because food processing can cause lysine to be modified in a way that makes it unavailable for protein synthesis, an issue recognized by the newly released FAO report on dietary protein quality [26].

1.6. Resistant Starch and Fiber

Beans contain high amounts of resistant starch (RS), generally defined as a portion of starch and products of starch degradation not digested in the small intestine [27]. The RS content of beans is much higher than in commonly consumed grains, most likely because of their high ratio of amylose to amylopectin; amylose is a non-branched, linear polymer of glucose units that is less readily digested than amylopectin. Beans are also rich in fiber, even compared with other unrefined plant foods, One-half cup of beans provides between 5.2 and 7.8 g of total fiber compared with ~1.7–4 g of fiber per a 0.5-cup serving of whole grains. They are also among the best sources of soluble fiber [28]. According to the National Cholesterol Education Program, 5–10 g soluble fiber/d reduces LDL cholesterol by ~5% [29]. One-half cup of beans provides between 0.6 and 2.4 g soluble fiber [30].

Beans generally have a low glycemic index (GI) compared with other carbohydrate-rich foods, likely a result of both their RS and fiber content. The GI of beans ranges from 29 to 38 compared with 50 for brown rice and 55 for rolled oats (Messina, 2014). The low GI of beans can potentially produce clinically relevant benefits. For instance, in a study where patients with diabetes were couched to increase their legume intake by at least 1 cup/d, glycated hemoglobin (Hb A1c) values decreased by 0.5% compared with a decrease of 0.3% (difference between treatments, $P < 0.001$) in response to supplementation with wheat fiber. A significant change in Hb A1c concentrations of as little as 1% has a

potential to reduce risk of ischemic heart disease (IHD) by 15–18% in people with diabetes [31].

1.7. Health Benefits of Eating Beans

Beans have a range of health benefits. Beans is beneficial for the reduction of heart diseases as elevated blood levels of triglycerides and cholesterol, especially LDL cholesterol, are significant contributing factors to heart disease [32]. High plasma levels of homocysteine have been associated with increased risk for cardiovascular disease. Although some studies have shown that folate may lower homocysteine levels and, therefore, heart disease risk, the topic remains controversial and more research is needed [33]. A varied diet low in saturated fat with ample fiber (especially soluble) and B vitamins are among the recommendations for reducing cardiovascular disease risk factors [32].

Several studies have shown that regular consumption of beans can help lower total and LDL cholesterol and other risk factors for heart disease [34]. One study showed a 38 percent lower risk of a nonfatal heart attack when a cup of cooked beans was consumed daily [35]. Other researchers reported significant reductions in blood cholesterol levels when canned beans were consumed on a daily basis [36]. Diabetes is becoming more prevalent throughout the world as the global obesity epidemic continues. Eating a variety of legumes, including beans, may be valuable not only in the prevention of diabetes but also in the management of blood sugar levels (Venn, & Mann, 2004). Beans are rich in complex carbohydrates (such as dietary fiber), which are digested more slowly. As a result, bean consumption has been shown to increase feelings of fullness and help regulate plasma glucose and insulin levels after meals [37]. Legume fiber was among the fiber types associated with reducing the risk for metabolic syndrome, which includes glucose disturbances and increased risk of diabetes [38].

According to a recent study, regularly consuming beans as part of a low-glycemic-index diet improved blood glucose management, reduced systolic blood pressure and decreased the risk of coronary heart disease [39]. Participants with Type 2 diabetes mellitus were placed randomly on a high-legume diet (consuming 1 cup per day) or on a high-insoluble-fiber diet with whole-wheat foods. Hemoglobin A1c (HbA1c), a measure of long-term glycemic control, was measured after three months. The group consuming the high-legume diet experienced a significant decrease in HbA1c and reduced their calculated heart disease risk scores [39].

The role of bean-containing diets related to cancer risk has been the subject of ongoing studies [40]. Eating beans may reduce the risk of developing certain types of cancers due to their contribution of bioactive compounds to the diet, including flavonoids, tannins, phenolic compounds, and other antioxidants [41]. These compounds act to decrease the risk of cancer, as well as other chronic diseases. Other researchers have shown that beans may have a synergistic effect when consumed in a diet containing other antioxidant-rich foods (such as fruits and vegetables) by decreasing oxidation in the body and reducing the overall cancer risk [42].

Bean intake has been associated with a decreased risk of breast, stomach, colorectal, kidney, and prostate cancers in human and animal studies [43]. In particular, the dietary fiber content of beans may play a role in reducing the risk of colorectal cancers [44]. For example, a study that examined the impact of dietary fiber intake on the development of colon polyps in a cancer survivor cohort found that people who consumed more fiber, specifically fiber from legumes and cooked green vegetables, including green beans and peas, were less likely to show a recurrence of polyps than others [44].

Even though beans are not often promoted as a weight-loss food, regularly consuming nutrient-rich legumes may affect weight loss or management, although more research is needed [45]. According to results from the National Health Nutrition Examination Survey 1999 to 2002, people who consumed beans regularly had a lower body weight, lower waist circumference, and lower systolic blood pressure, in addition to

a greater intake of dietary fiber, potassium, magnesium, iron, and copper [46]. According to the results of studies conducted in Brazil, a traditional diet high in rice and beans was associated with a lower body mass index (BMI), compared with a typical Western diet containing more fat, snacks, and soda [47].

Consuming beans may contribute to feelings of short-term satiety because of the beans' fiber and protein content [48]. In a study of 35 obese men fed four different protein-rich diets, the diet providing the majority of protein from legumes (including beans) induced the greatest amount of weight loss in an eight-week period. The group instructed to eat legumes at least four days a week also experienced significant reductions in waist circumference, body fat mass, blood pressure, and total cholesterol when compared with the other groups [49]. Researchers have studied the role of hormones, including leptin and ghrelin, in regulating appetite and weight. Researchers determined the leptin and ghrelin levels in 36 insulin-sensitive and 28 insulin-resistant men. Leptin levels decreased among the group consuming a diet enriched with legumes. When leptin is present in smaller concentrations, it is more effective in regulating appetite and may aid in weight loss and weight maintenance [49].

2. Materials and Methods

2.1. Study Area

The experiment was carried out at the Food laboratory at the University for Development Studies, Department of Family and Consumer Science. The area lies within the Guinea Savannah zone of Ghana which falls on latitude 9° 25′ 141″, longitude 0° 58′ 142″, and an altitude of about 183 m above sea level. The study area is located in Nyankpala, Tolon District in the Northern region of Ghana. Nyankpala is a native rural farming community with the majority of its natives below the middle class. The main occupation in this area is agriculture. Ghana Statistical Service, (2014) revealed that about 90 percent of the households in this area depend on crop farming for livelihood. Bean is one of the food crops grown in the district and it is mostly grown for food and as a cash crop. Bean is a major source of dietary protein and an essential component of the cropping systems in this area.

2.2. Research Design

Research is a process that is the step combination that is done systematically and logically to get the solution to the problems or to get the answer to the question [50]. "Experimental research design is to enable the researcher to estimate the effect of an experimental treatment" [51]. This experimental research was done in the food and nutrition laboratory at the Department of Family and Consumer Sciences in the University for Development Studies. This research employed the quasi-experimental design to establish a cause-and-effect relationship between an independent and dependent variable, here the independent variable is cooking time and the dependent variable is the softness of the beans when cooked. A quasi-experimental design is a useful tool in situations where true experiments cannot be used for ethical or practical reasons.

2.3. Materials

2.3.1. Beans

The beans used for this experiment were locally cultivated and mostly consumed variety in Ghana popularly known as black eye beans. It is about 6- 9 mm of size and was obtained from a local market in tamale.

2.3.2. Onion

The onion used for the experiment is Bawku Red which is commonly cultivated in Ghana and available across the country. The bulb varies in size, shape, and color. The

largest bulb may have a diameter of about 8 cm and a shape range from pink and purple to red. It is very pungent in smell.

2.3.3. Cassava

A locally cultivated cassava was used for this study. The cassava was purchased in a local market in Tamale, Northern Region of Ghana. The cassava is a known variety in most Ghanaian communities.

2.3.4. Equipment

In order to study the cooking of beans, the following equipment were used:

- Water bath, 10 L
- Pot, 5L
- Burner (gas)
- Three decimal scale
- Plastic cups for weighing beans and water
- Spoon to help in test for softness

2.4 Methods

In this experiment, the addition of Onion to beans during cooking and the addition of fresh cassava during cooking were studied.

2.4.1. Experiments and Treatments

T_o = *dry beans with no additive*

T_c = *Addition of blended onions to dry beans during cooking*

T_{BO} = *Addition of crushed cassava to dry beans during cooking*

2.4.2. Onion Treatment

Three sizable onion bulbs were used for each text. The onions were carefully washed and bended using an electric blender with little addition of water. A quantity, 150 ml of the blended onions was used for each text for T_c.

2.4.3. Cassava Treatment

The cassava was carefully peeled using a knife. The peeled cassava was washed in water to clean it. After cleaning was done, 40g each of the cassava was weighted and crushed using a mortar and pestle into very sizable pieces of about 5-10 mm. Care was taken not to crush the cassava into fine pieces.

2.5. Experiment Procedure

The experiment was conducted in two days. Cleaning of the beans was done on the first day. The cooking was also carried out on the second day. During cooking a stop clock was used to measure the time for the beans to reach total softness. The evaluation of other parameters were carried out on the same day of the experiment and the results collected.

2.5.1. Cooking beans

This is the time taking for a greater percentage (80 percent) of the bean grain to be softened (cooked). To determine the cooking time of beans, texture (i.e., hardness or softness) assessments were used, in which beans were classified according to how easily their cotyledons disintegrate when a force is applied [52]. To determine the cooking time, a stopwatch was used to measure the time between when the beans is added to the boiled water and the time at which the beans were well cooked.

The set-ups were put on a gas burner and the same amount of heat was applied for all the treatments. In test one (1), 1 litre of blended onions and crushed cassava were added to the bean samples labeled T_c and T_{BO} respectively during cooking, and sample T_o were dry beans cooked with no additives.

2.6. Data Collection and Presentation

The data was collected on cooking time and quantity of water used. The data was subjected to analyses using Microsoft Excel version 2016 and the results were presented using tables and chats. The chats were used to present the performance of the various treatments in terms of cooking time.

3. Results and Discussion

This section presents results and discussion obtained from the laboratory experiments conducted with beans to determine the protocol that will help reduce the cooking time of beans. All the treatments in this test were given to dried beans. Table 2 below presents the results (cooking time and quantity or water) obtained from the test.

Table 2. Cooking time and Quantity of Water -T2

Test ID no.	Experiment	Treatment	Time (minutes)	Quantity of Water (*l*)	
				Initial	Added
T_o	Dried beans	-	47	1.9	1
T_{BO}	Dried beans	crushed Cassava	46	1.9	1.5
T_C	Dried beans	Blended Onions	43	1.9	1

3.1. Observations

- In Too (Dried beans with no additives), the initial water used which was 1.9 liters was used up and additional 11 liters of water was added. This means the initial water was not enough to cook the beans. The beans were well cooked after 47 minutes of cooking.
- In T_{BO} (Dried beans + crushed Cassava), Additional 1.5 liters of water was added during cooking. The beans were well-cooked after 46 minutes.
- In T_c (Dried beans + Blended Onions); A1iter of water was added to the initial water which is 1.9 liters. This means the initial water was not enough to cook the beans. The beans were well cooked after 43 minutes of cooking.

3.2. Effect of Addition of Onions

The addition of onion did have much significant effect on the cooking of dry beans. Again in terms of water used, the treatments (addition of blended onion) with dry beans used 2.9 liters of water for 100 grams of beans used for the experiment.

3.3. Effect of the addition of crushed cassava.

The addition of crushed cassava had very little effect on the cooking time of dry beans. It recorded a cooking time of 46 minutes which is a 1-minute reduction as compared to dry beans with no additives (47 minutes). Again in terms of water used, the treatment (addition of crushed cassava) with dry beans used more quantity of water (2.9 litres) during cooking as compared to dry beans without treatment and with blended onions.

4. Conclusions and Recommendations

4.1. Conclusions

The study was aimed at reducing the cooking time for beans and shows that the addition of blended onion to dry bean is outstanding in performance in minimizing cooking time. This was evident in the results as cooking time was seen to reduce from 47 minutes (dry beans) to 43 when blended onion is added. The study also shows that adding crushed cassava also shows a significant change in cooking time for beans from 47minutes to 46minutes.

4.2. Recommendation

- It is recommended that crushed onions are added to help reduce the cooking time of beans. Especially by homemakers who may not have time to soak beans prior to cooking.
- Further research should be carried out to assess the sensory analysis of cooking dry beans with crushed onion and cassava to ascertain its acceptability.
- Proximate analysis should also be carried out to show the effects of various treatments on the nutritional content of beans after cooking with them.

5. Implications of the Study

A bean is a leguminous plant that is mostly cultivated for its seeds. It is one of the common food crops produced in Ghana due to its cheap source of nutrients as well as a potential source of income for subsistence farmers who cultivate legumes at the household level. Cooking beans is necessary to achieve palatability and increased digestibility of nutrients, reduce/eliminate anti-nutrients, and improved sensorial attributes such as aroma, taste, and texture. This study was aimed at reducing the cooking time for beans by evaluating the effect of the addition of onion and crushed cassava on the cooking time of beans. Black eye bean was used for the experiment. It was found that adding blended onion to dry beans reduced the cooking time of beans. The addition of onion revealed a potential reduction in cooking time in dry beans and recorded a cooking time of 43 minutes. The addition of cassava also produced a similar potential in reducing the cooking time for dry beans and recorded 46 minutes as compared to 47 minutes of cooking dry beans.

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