Instant Cooking Cowpeas

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Abstract: ***Cowpeas are important grain legumes. Despite their high nutritional qualities, they are underutilized because of their hard-to-cook phenomenon thus this study was aimed at shortening the cooking time of cowpeas. Red, brown and white cowpea varieties obtained from Madina Market, Accrawere sorted to remove damaged and infected seeds. Functional properties of the three varieties were determined by standard methods. Raw cowpea varieties were soaked at 1 and 3 hours respectively at room temperature to determine their cooking time. The soaked cowpeas were drained and cooked in a jacketed pan with steam as a source of heat at a pressure of 50ibper square inch and oven dried (90°C). Rehydration of the dried precooked cowpeas was determined at 27°C and 70°C. Results of functional properties showed a variation in the 3 varieties of cowpeas. The cooking time of the dried precooked cowpeas was also determined and the results showed a significant reduction in the cooking time of the varieties respectively.***

Keywords: Hard-to-cook, cowpeas, cooking time, functional properties

1. Introduction

Grain legumes form an essential part of human nutrition in the world. In sub-Saharan countries such as Ghana where animal protein is seldom affordable for the poor, legumes are the only source of protein and other nutrients such as B vitamins and minerals (Report, 1979). The consumption of these legumes such as cowpea can help control problems of malnutrition in many tropical regions of Africa.

Cowpea (vignaunguiculata) is one of the most widely distributed grain legumes throughout the tropics and an important food legume crop in many African countries such as Ghana because they are low in antinutritional factors (Phillips and McWatters, 1991; Kay, 1979). They are good sources of proteins, cellulose fiber and carbohydrates. The protein content is within the range of 23-27%, almost double the protein value of most cereals and the protein fractions are mainly water-insoluble globulins and water-soluble albumins which make up about 90% and 10% of the total protein respectively (Singh et al., 1997). The amino acid composition of cowpea protein is deficient in cystine, methionine and tryptophan (Singh et al., 1997).The carbohydrates consist of starch, sucrose, oligosaccharides such as stachyose, verbose and raffinose (Reddy et al., 1984). Sucrose is the major sugar. The oligosaccharides are poorly ingested resulting in flatulence as a result of microbial action on oligosaccharides in the large intestines (deMan, 1999).

In spite of the high nutritional value, the grain legume is under-utilized as food. The constraint to the utilization is their decreased cookability after storage at high temperatures and humidities (Morris, 1963; Burr et al., 1968). This is known as Hard-to-Cook defect. It is distinguished from "hard-shell" or "hard-coat" which is principally related to impermeability of the seed coat to water (Liu, 1995). According to Bressani (1993), this defect is thought to be the result of incomplete breakdown of the middle lamella or cell wall complex that inhibits cell separation, heat transfer, starch gelatinization and protein denaturation. In this phenomenon the grain legumes are capable of absorbing water but do not soften even when they are fully hydrated (Bressani, 1993). Hard-to-cook beans tend to use more energy creating an economic problem during preparation. Cowpeas also contain various antinutritional factors that negatively affect their nutritional quality. The antinutritional aspects of cowpeas are due to the presence of trypsin inhibitor, haemagglutinin and phytic acids (Fennema, 1996). The constituents are toxic but can be inactivated by adequate heat treatment (Fennema, 1996).

In order to encourage cowpea utilization, the hard-to-cook phenomenon coupled with the intestinal gas formation must be reduced. Thus the rational for this study is to shorten the time required to cook cowpeas and also reduce the flatulence caused by oligosaccharides constituents of the cowpea.

2. Materials and Methods

2.1. Sample Preparation

Three cowpea varieties namely white, red and brown were obtained from Madina Market, Accra. The cowpea samples obtained were sorted out manually to remove foreign matter and damaged seeds and stored in the cold room at a temperature of 8°C.

2.1.1. Whole Seed Weight Determination

This determination was carried out using the method described by Sefa-Dedeh and Stanley, (1979a). The weight of 100 randomly selected seeds were determined and estimated to the weight for 1000 seeds.

2.2. Functional Characteristics of Cowpea Varieties

2.2.1. Bulk Density of Seeds

Bulk density determinations were done by the methods reported by Wang and Kinsella (1976).

A pre-weighed 100ml graduated cylinder was filled to the mark with the cowpea. The sample was then packed by gently tapping the cylinder the cylinder on the bench. The volume and weight were recorded. The bulk density was calculated as the ratio of the weight (g) to volume after packing (ml).

2.2.2. Seed Water Absorption

Water absorption capacity of whole seeds was determined according to the method of Sefa-Dedehet al., 1978). Ten grams of each cowpea seed was soaked in 100ml distilled water for the periods of 1, 3, 6, 12, 18 and 24 hours respectively. The increased in weight after imbibition of water was reported in gram water per 100g dry seeds.

2.2.3. Swelling Property

This determination was carried out using the method of Sefa-Dedeh and Yiadom-Faakye, (1988). Ten seeds of each cowpea variety were randomly selected and measured for dimensions of length, width and thickness. The mean of these measurements were recorded and the cowpea seeds were soaked in different test tubes filled with 50ml distilled water. Each set of ten seeds was allowed to soak for 1, 3, 6, 12, 18 and 24 hours at 27^{o}C and 70^{o}C. After the soaking period, the dimensions were recorded and the degree of swelling calculated as the swelling ratio.

Seed swelling ratio= dimensions of seed after soaking/ dimensions of seed before soaking.

2.2.4. Soluble Solid Determination

15ml steep water was obtained after soaking 500g of cowpea varieties in 1500ml water for 3 hours. The 15ml steep water was weighed and dried in an air oven overnight to determine the soluble solids present in the cowpea varieties.

2.3. Preparation of Precook Dried Cowpeas

500g of the cowpea varieties were soaked in 1500ml of water for 1 and 3 hours respectively. The soaked seeds were cooked in 2000ml of water at 100^{o}C in a jacketed pan with steam at a pressure of 50ibper square inch. The cooked samples were drained and spread out on aluminium trays and oven dried (90^{o}C) overnight. The dried precook samples were then packaged and later reconstituted to determine the cooking time.

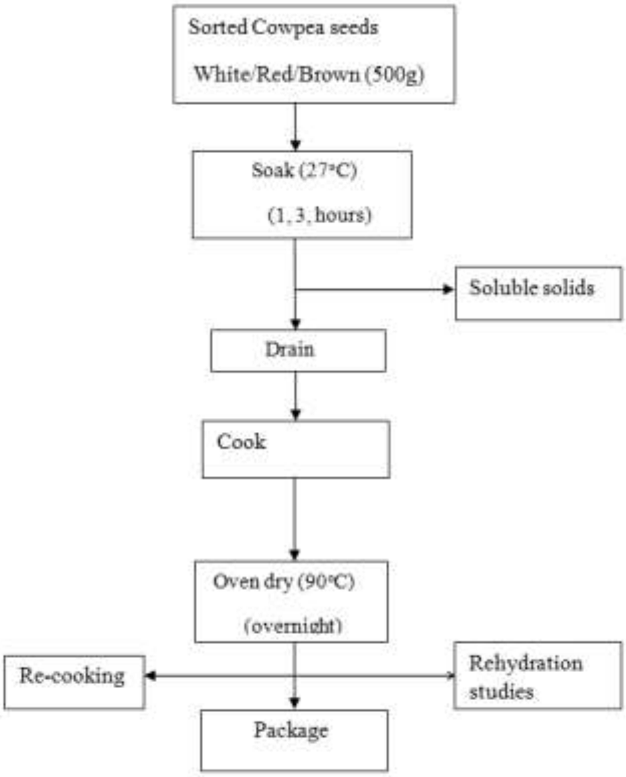

Figure 1: Flow diagram for the preparation of precook dried cowpea

2.4. Rehydration of Precook Dried Cowpea

About 10 pre-weighed seeds of white, red and brown precook dried cowpeas were rehydrated in 10 test- tubes for 50 minutes and weighed at 5 minutes intervals to determine the rate of water absorption. Rehydration was done at 27^{o}C and 70^{o}C and reported in gram water/10g.

3. Results and Discussion

3.1. Seeds Physical Characteristics

Cowpea varieties have diverse seed types. The seed types vary in sizes, shapes, and colour – white, red, brown, black, cream and mottled (Sefa-Dedeh and Stanley, 1979c) and may also have smooth or rough testa. Tables1 and 2 respectively describe the general appearance and dimensions and weights of the three cowpea varieties used. The dimensions differed significantly ($P<0.05$) among the cowpea varieties. The differences in the seed coat colour impart peculiar characteristics which are suitable for different purposes such as in akara or moin-moin preparations, where the preferred varieties of cowpea used are those of white or pale coloured seeds, with rough seed coat, since they require shorter periods of soaking before dehulling (Kay, 1979).
The white cowpea varieties were longer, wider and thicker (0.81±0.03, 0.66±0.03 and 0.46±0.01) cm than the other varieties and also had the largest approximate volume (0.44±0.04)cm^3 and weight (256.3±0.1)g/1000seeds. The brown varieties were the least in respect of length, width, thickness and approximate volume (0.74±0.06, 0.59±0.01, 042±0.01)cm and 0.19cm^3. The differences in volume of

cowpea varieties might be due to differences in their cotyledon size.

Table 1: General Appearance of Raw Cowpea Varieties

Cowpea Varieties	Seed Coat colour	Eye Colour	Seed coat Texture	
Red	Red	Brown	smooth	
White	White	Black, brown	rough	
Brown	Brown	Brown	smooth	

Table 2: Dimensions and Weights of Cowpea Varieties

Varieties	Length(cm)	Width (cm)	Thickness (cm)	Approximate Volume (cm^3)	Weight of 1000 seed (g)
Red	0.81±0.03	0.66±0.03	0.46±0.01	0.25±0.07	131.2±0.2
White	0.99±0.01	0.74±0.02	0.60±0.01	0.44±0.04	256.3±0.1
Brown	0.74±0.06	0.59±0.01	0.42±0.01	0.19±0.08	106.2±0.1

3.2. Bulk Density

Figure 2 shows the bulk densities of the three cowpea varieties. Significant differences ($P<0.05$) exist in the bulk densities of the cowpeas. The brown variety had the highest bulk density followed by the red and then the white respectively.

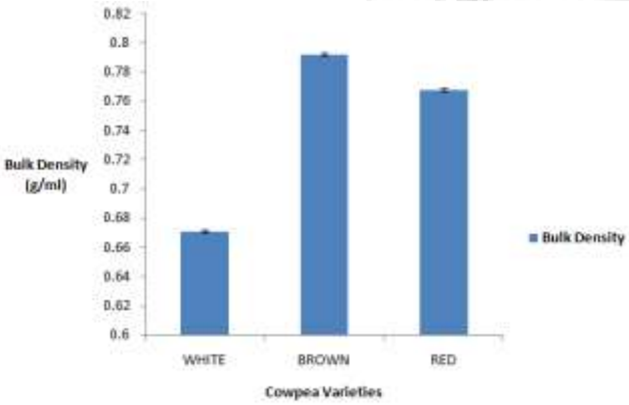

Figure 2: Bulk Density of Cowpea Varieties

Among the varieties studied, the white seeds which recorded the largest seed sizes had the least bulk density (0.671±0.001)g/ml. Wang and Kinsella (1976) observed that small and even particle size distribution contributes to increased bulk density. This was observed as the brown varieties with the smallest seed sizes had the highest bulk density (0.792±0.001) g/ml. The small seed sizes of the brown varieties were packed more tightly together which therefore occupied a greater mass per unit volume of space than the larger size seeds of the white and the red varieties. This observation implies that seed size influences bulk density negatively as larger seeds increased the number of spaces between seeds thus reducing the mass of seeds that can be packed into a fixed volume.

3.3. Water Absorption Capacity of Cowpeas

The amount of water absorbed per 100g of cowpea varieties at 27^{o}C and 70^{o}C respectively when soaked at different times is illustrated in figure 3. Among the three varieties, significant differences ($P<0.05$) exist in the pattern of water absorption at both temperatures within the twenty-four hours of time allowed.

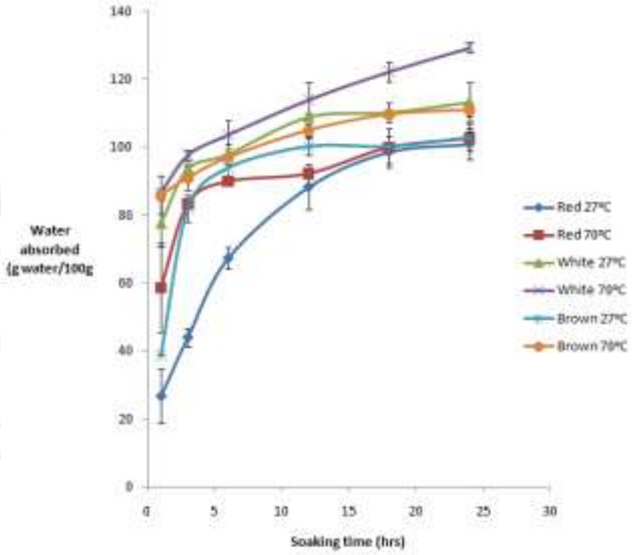

Figure 3: Water Absorption of Cowpea Varieties at 27^{o}C and 70^{o}C

At 27^{o}C, the rate of water absorption within six hours differed significantly among the varieties with the white variety showing a significantly higher rate of absorption of water than brown and Beyond the six hours, water absorption leveled off more in the brown (100.33, 100.33, 103.00)g/100g and white (109.00, 110.33, 113.33)g/100g varieties as compared to the red cowpeas (88.33, 98.67, 101.00)g/100g as absorption reached saturation at 27^{o}C. After the sixth hour, the stabilization in water absorption which was quite easily attained by brown and white varieties, while red varieties attained stabilization from the eighteenth hour of water absorption might be due to the development of internal pressure which resulted in less swelling for the same degree of moisture absorption (Taiwoet al., 1998). The hydration properties of the seeds have mainly been associated with structure characteristics of the seed coat and cotyledon, protein content and other macromolecules such as cell wall materials and pectins (Sefa-Dedeh and Stanley, 1979b).At the end of the twenty-four-hour period of water absorption at 27^{o}C, the quantity of water absorbed did not show any significant difference in red and brown cowpeas as compared to the white variety. This might be due to the higher water binding capacity of its starch. The minimal water uptake with extended soaking time due to resistant swelling have been reported by Taiwoet al., 1998, to be caused by the unsolvated structural network of solids. Singh and

Kulshrestha (1987) also suggested that extended soaking times would inhibit water absorption. At 70°C, the amount of water absorbed from the initial soaking time increased continually to the twenty-fourth hour of water absorption in the white varieties. The white varieties increased more steeply than the other varieties as the soaking time increased. The initial water absorption during the first hour was not significant for the white and the brown varieties unlike the red ones which was lower initially and rose steeply to the third hour. The water absorption curve stabilized during the sixth and twelfth hours of water absorption before it rose again to the eighteenth hour in the red cowpea varieties. Water absorption shows no difference significantly in the red and brown varieties from the eighteenth hour. The amount of water absorbed at the end of the twenty-four hour period was greatest in the white varieties than the brown and the red cowpeas respectively.

It can be observed that water absorption of each variety at 70°C and 27°C show significant differences within the soaking time period. Water absorption is higher at 70°C for each variety than at 27°C. The increased temperature caused some amount of solubilization of the middle lamella pectin polymers which influenced water absorption (Sefa-Dedehet al., 1978). The cell separation resulted in increased water absorption at 70°C for each variety and thus, reducing the internal pressure development as compared to the water absorption at 27°C. At both temperatures, the white cowpeas absorb more water than brown and red cowpeas respectively.

3.3.1. Water Absorption Constant of Cowpea Varieties

The water absorption constant shows how the three varieties absorbed water (Figures 4, 5, 6).

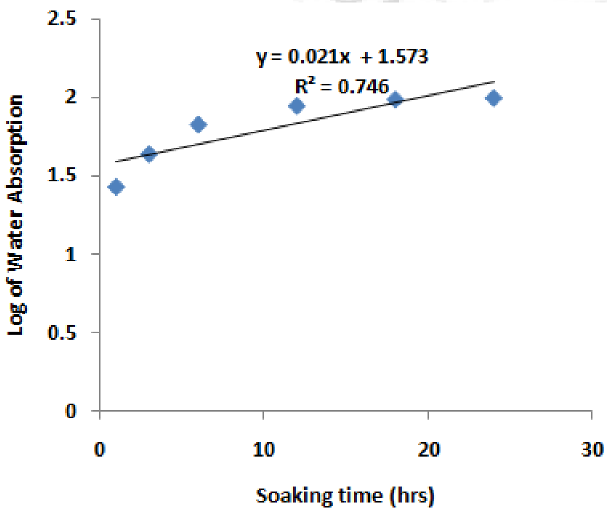

Figure 4: Log of Water Absorption for Red Cowpea Varieties

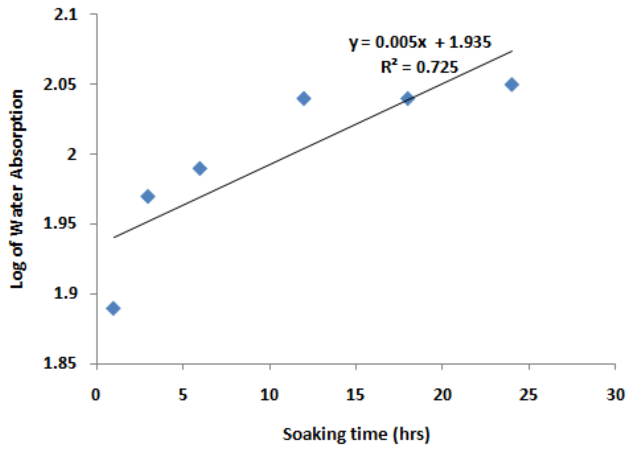

Figure 5: Log of Water Absorption for White Cowpea Varieties

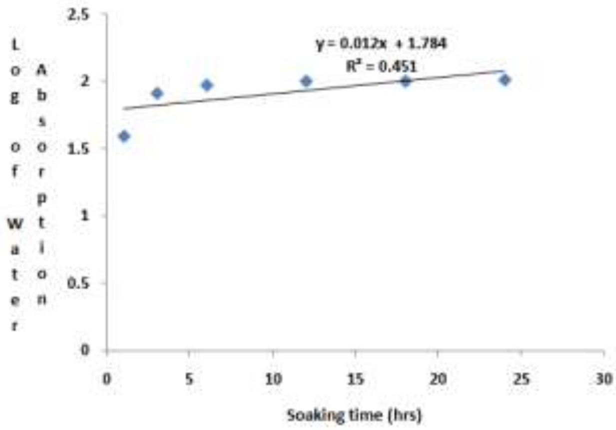

Figure 6: Log of Water Absorption for Brown Cowpea Varieties

It can be observed that the absorption constant for the white variety was 0.005 (Figure 4). The brown variety was 0.012 (Figure 5) and that of the red was also 0.021 (Figure 6). It can therefore be deduced that the white varieties imbibe water at a faster and shorter time than the brown cowpeas and followed by the red varieties respectively. This is also an indication that within the same time period, the white varieties will absorb a higher amount of water, followed by the brown varieties and the red ones respectively.

3.4. Swelling Property of Cowpea Seeds

Figure 7 shows the swelling volume properties of the three cowpea varieties at 27°C and 70°C.

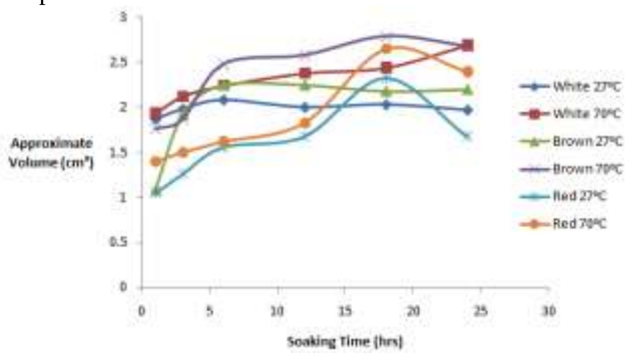

Figure 7: Approximate Swelling Volume of Cowpea Varieties at 27°C and 70°C

Though the brown cowpea seed sizes were the smallest, its expansion in relation to its size was the highest. The volume of expansion was very critical within the first six hours for the white and the brown cowpeas but due to the development of internal pressure, their volume of expansion was not significantly different beyond the sixth hour. The approximate volume of the red cowpeas expanded most at the eighteenth hour before it decreased at the twenty-fourth hour period. The swelling of starch is influenced by temperature and this phenomenon can be observed in Figure 7. At an elevated temperature of 70^{o}C, the starch granules swell more causing an increase in the volume of expansion of the cowpeas. It can therefore be observed that at 70^{o}C, the approximate volume of expansion after water absorption was greater than those obtained at 27^{o}C.

3.5. Soluble Solids of Cowpea Varieties

The leaching of sugars (oligosaccharides) or soluble solids in steep water after soaking for three hours can be observed in figure 8. There is a significant difference (P< 0.05) in the leaching of soluble solids among the cowpea varieties. The steep water of the white cowpea varieties contained more soluble solids followed by the brown and the red varieties respectively. The amount of oligosaccharides loss in the white varieties was 0.61g/100g (61%), 0.15g/100g (15%) in the red varieties and 0.49g/100g (49%) in the brown varieties. Among the three varieties studied the oligosaccharide loss after soaking for three hours ranged between 15-61%. It is possible that leaching of soluble solids corresponded to thickness of the cowpea seed coat. Thinner seed coats enhance rapid softening during soaking (Sefa-Dedehet al., 1978) and as observed earlier, the water absorption constant of white varieties which was faster may correspond to the rate of soluble solid leach out within the three hours of soaking. The red varieties with low water absorption rate due to thicker seed coats recorded the lowest leach out of soluble solids.

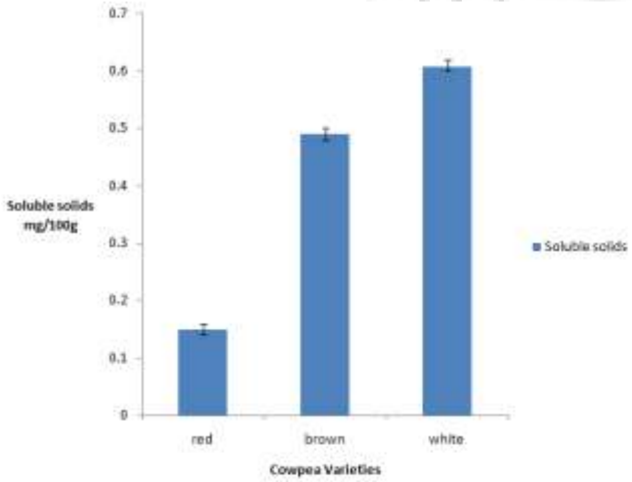

Figure 8: Effect of Soaking on Soluble Solids of Cowpea Varieties

3.6. Cooking Time of Cowpea Varieties

The time required for cooking cowpeas to an acceptable texture and flavor varies depending on factors such as variety and soaking time (Taiwo, 1998).

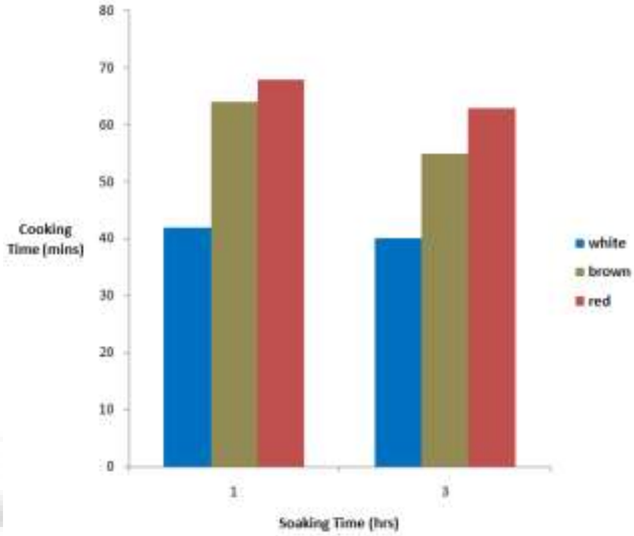

Figure 9: Effect of Soaking on Cooking Time of Cowpea Varieties

Figure 9 compares the cooking time among cowpea varieties after soaking for 1 and 3 hours. It can be observed that cooking time was reduced when varieties were soaked for 3 hours as compared to the 1 hour of soaking. During the 1 and 3 hours of soaking, the red varieties cooked at a longer time, followed by the brown varieties and the white varieties respectively. The cooking time for the brown varieties was 64 minutes when soaked for 1 hour and 55 minutes when soaked for 3 hours. However, the white varieties cooked at 42 minutes at 1hour soaking and 40 minutes at 3 hour soaking with the red varieties recording a cooking time of 68 minutes when soaked for 1 hour and 63 minutes when soaked for 3 hours. Soaking resulted in water absorption which moistened and softened the seed before cooking. The process of cooking to a soft texture is mainly characterized by cotyledon parenchyma cell separation, protein denaturation and starch gelatinization (Sefa-Dedehet al., 1978). At 3 hours of soaking, more water was absorbed to reduce the cooking time. The white varieties cooked at a shorter time to a soft texture followed by the brown and the red varieties because the white varieties absorbed more water than the other varieties.

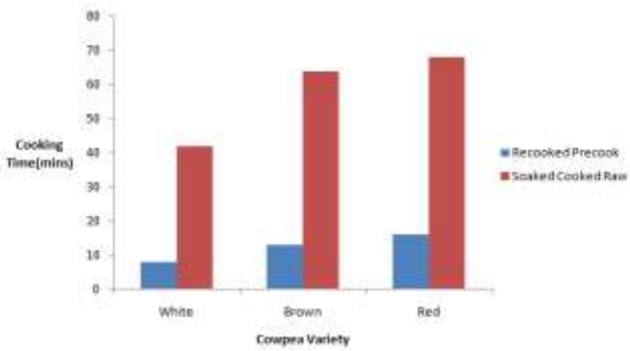

Figure 10: Comparing Cooking Time of Raw and Precook Dried Cowpea Varieties

In Figure 10, the cooking time of precooked cowpea product was compared to the cooking time of the raw cowpeas. The cooking time of the raw cowpeas after 1 hour soaking at room temperature ranged from forty-two minutes to sixty-eight minutes. The cooking time for the precooked dried cowpeas drastically reduced and ranged from 8 minutes to 16 minutes.

It was noted that the pattern of reduction observed in cooking time in the raw cowpeas was similar to the pattern of reduction observed in the precooked cowpeas. In the raw cowpeas, the white varieties cooked faster followed by the brown and the red varieties. The same pattern was observed in the precooked cowpea product where the white varieties cooked faster followed by the brown varieties and then the red varieties respectively. The white varieties cooked at a shorter time than the other varieties because of its higher water absorption during rehydration.

The percentage reduction in cooking time in the precooked dried cowpeas was 525% (white), 492% (Brown), and 425% (Red) respectively. Precooking cowpeas reduced the long cooking times possibly through gelatinization of the starch, denaturation of the protein and increased pectin solubility (Cenkowski and Sosulski, 1997). This resulted in improved hydration and reduction in cooking time of precooked seeds.

3.7. Rehydration Relationship between Precook Dried and Raw cowpea Varieties

Figures 11 and 12 compare the rehydration of precooked cowpea products and the water absorption of the raw cowpeas at 27°C and70°C. The precooked cowpeas at both temperatures studied absorbed more water than the raw cowpeas. The lower rate of water absorption by the raw cowpeas can be attributed to the hardshell related to seed coat and its impermeability to water and the hardshell related to cotyledon impermeability (Morris et al., 1950). However in the precooked dried cowpeas these factors have been reduced thus increasing rehydration rate and ultimately reducing cooking time.

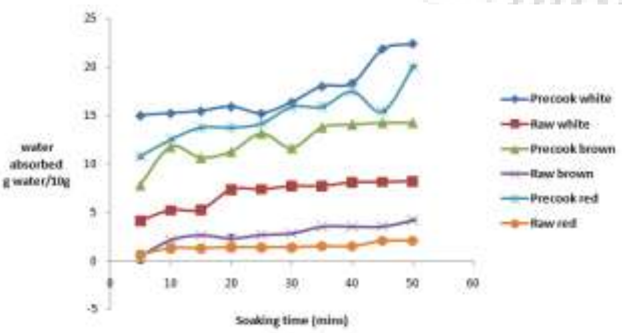

Figure 11: Comparing Rehydration of Precooked and Raw Cowpea Varieties at 27°C

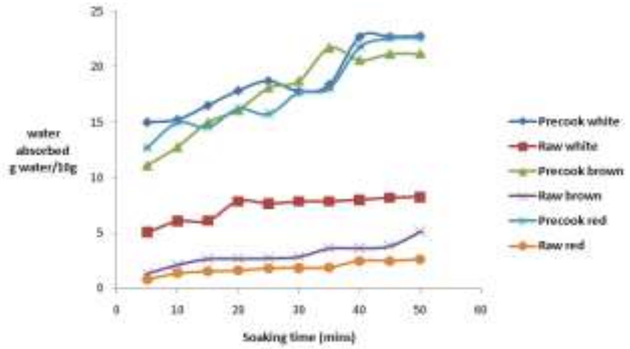

Figure 12: Comparing Rehydration of Precooked and Raw Cowpea Varieties at 70°C

4. Conclusion

The hard-to-cook nature of cowpeas which undermines its usage has been removed in this study and hence the longer cooking time has been shortened significantly. On functional properties:

- The white cowpea varieties were bigger in size and weighed more as compared to the red and the brown varieties respectively.
- The three cowpea varieties absorbed water differently and swelled at different rates.
- Soaking cowpea varieties contributed to leaching of soluble solids into steep water.
- Rehydration of raw and precooked cowpeas show that the precooked cowpeas absorbed more water.

On cooking properties:

- The cooking time of precook dried cowpeas showed a 525%, 492% and 425% reduction in cooking time of white, brown and red precooked dried cowpeas respectively.
- The amount of water absorbed influence the cooking time of the raw cowpea varieties. The white varieties which absorbed the most amount of water cooked faster than the brown and the red varieties respectively.

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