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Functional and Pasting Properties of Sprouted Grains of Jack beans (*Canavalia ensiformis* (L.) DC.) Flour at Different Periods of Exposure

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Abstract

Germination is a highly effective way of pre-processing that involves numerous changes in the structure of molecules, resulting to increases in the flour attributes. The effect of germination on the quality of Jack bean (*Canavalia ensiformis*) (L) DC flour was the primary subject of this investigation. Before allowing the seeds to germinate for duration of one to nine days, any damaged seeds were meticulously removed from the batch. The sprouted beans and the raw (control) beans were subsequently processed into flour and tested for their functional and pasting qualities. The data suggested that germination for a length of nine days (X_5) resulted in flour samples with improved quality attributes. These included water uptake capacity of 1.50 G/g, oil uptake capacity of 1.35 G/g, Foaming Capacity (FC) of 1.43%, Swelling Capacity (SC) of 3.00%, bulk density of 0.79 G/ml, pH level of 7.20, Total Titratable Acidity (TTA) of 0.08 mg/100g, and a brix value of 5.99. Additionally, the flour displayed better pasting qualities, with peak viscosity measuring 225.02 RVU, trough1 at 90.01 RVU, breakdown of 135.00 RVU, final viscosity of 123.00 RVU, setback of 33.00 RVU, peak time of 6.51 minutes, and a pasting temperature of 87.17 ^{0}C. Germination as a pre-treatment approach resulted to increases in both functional and pasting qualities, hence enabling the flour to perform extraordinarily well throughout later processing steps.

Keywords: Functional properties, pasting properties, Jack bean, sprouting

Introduction

Tropical legumes include the following: Jack bean – in the Yoruba language it is called “Sese nla” which is scientifically referred to as *Canavalia ensiformis* (L.) DC [1, 2]. Unfortunately, most of these underdeveloped countries, including Nigeria, continue not to utilize the Jack bean efficiently. However, this has greatly limited the maximum utilization, growth and development of the legume attributing to its nutritional rich values. Some

Nigerians view the seed as just mere "snake dismissal," while others sow it with perhaps aesthetic intentions in mind [2]. This crop is edible and also used in preparing value added food products that are trending in the market. The flow properties and the flour pasting attributes have been influenced due to highly hard testa, and prolonged processing time associated with it. This means that processing characteristics produced from bean flour samples are influenced by the processing parameters that are used [4].

However, there are some problems with legumes i.e. anti-nutritional factors, long time of preparation and it has hard seed coat. They are less evident in the flesh forming nuts, but have caused a considerable modification of the processing and nutritional properties of the crop than in other legumes, especially Jack bean.

The negative attributes, including poor digestibility, phytate content, and detrimental effects on the nutritional composition of legumes, have been partly addressed through a host of pre-treatments that aim to address these perennial challenges. These have led to enhanced nutritional value and functional value of food crops that grow on the plants. Among the widely applied pre-treatment techniques are dipping the grains in hot water as well as boiling them in water, heat-treatment in acidic and/or alkaline solutions, fermentation, steam treatment, dry heat application, hull removal, microwaving, water vapour treatment and germination [5, 6].

Germination of leguminous seeds has led to the decline of nutrient opposing factors and improvement in protein and the other nutrient values as well depending on the tests [7, 8, 9]. These plant proteins remain the essence of human diet because protein obtained from animal remains costly for the less privileged [10].

Other than enhancing the taste and texture of foods for human consumption, food processing affects the accessibility to nutrients by neutralizing some of the nutrient antagonists and growth inhibitors [11]. Exploration in the findings has shown that the seed and grain product quality could be improved by sprouting, soaking/fermentation, autoclaving, blanching or roasting [12, 13, 11]. Soybean germination has been observed to enhance the ascorbic acid, riboflavin as well as niacin [18].

Most of the reported studies on Jack beans are confined to the role of the plant in livestock production, particularly in feeding [15]. This has actually led to low utilization of the Jack bean in rising nations regardless of the potential of sprouting in advancing the functionality and pasting attributes of the food material [16, 2]. This inquiry therefore sought to establish the effect for sprouting on the functional and pasting properties of flour from crop under study (Jack bean).

Materials and Methods

Material

Jack bean (*Canavalia ensiformis* (L.) DC.) with distinguishing number: (TCe4) seeds were obtained from International Institute of Tropical Agriculture (IITA) specifically the seed bank of the Genetic Resources Unit, Ibadan, Oyo State. Nigeria.

Sprouting procedure for Jack bean seed

For this treatment method, the following modification was made. A c viewing the procedure, 200g of beans was soaked in 1500 millilitre of distilled water for 24 hrs at ambient heat. The soaked seeds were rinsed while allowing individual section to sprout for days ranging from 1 to 5 days accordingly with an added frontal soaking process. The malted beans were left in a cabinet drier for a period of six hours until it reached a moisture content of 12 % at temperature of 45 + 2 0C. These were then subjected to some treatments and the plumules was the first to be removed before milling into flour.

Production of Flour from untreated and sprouted Jack bean

Matured beans were sorted to ensure that any bad seeds are removed this process dully compliments Jack bean by grading as well rightfully. The seeds were first washed in water to dehisce the shells, and the seeds were then left in warm water for them to soften. Working the palms constantly between the hulls extracting the oils separated from the mesocarp. The dehulled seeds served to proceed to the draining as well as to drying method to achieve consistent moisture content to facilitate grinding to flour. This new technique of [18] was used for sprouting as well. An experiment was carried out whereby two hundred grams of beans were wet with one thousand, five hundred millilitres of water at room temperature and left to simmer for twenty-four hours. The beans that had been soaked were washed; where by each component was allowed to sprout at different days, that is, for one to five days accordingly. The blotting paper packages were sprinkled and then rolled twice a day in other to ensure that the temperature of the chamber did not rise beyond 19 ^{0}C. Again, the packages were flooded with 27 ppm formaldehyde to minimize mold proliferation.' The sprouting beans were then spread on the cabinet drier at temperature of 45 + 2 ^{0}C for 6 hrs to 12% moisture content. This implies that the raw material, in this case, the plumules were stripped off before the final product of flour was made. There were ground into small particle size and then filtered to get fine powder without lumps some particles sized at 1 mm were used in preparing the control sample. The flour samples were stored in airtight container to ensure that they were ready for further analysis [19].

Functional Properties Determination

Swelling Power / Solubility

The method used for this study was the one provided in reference [20]. It is specified to take one gram (1 g) of the material, which was accurately weighed and placed in a 50 ml graduated cylinder bearing the concentration. 50 cc of distilled water was then added and mixed very gently under the sterile setting in the laminar flow. The mixture was then heated in a bain-marie while stirring so as to ensure even distribution of the starch granules without clumping at the base of the saucepan. After this, it was pelleted at a force of 88 xg for a total of 10 minutes to the bottom. The solid was dissolved in the said liquid and left to evaporate to determine the number of compounds dissolved and used to determine the solubility. The sediment weight was recorded and swelling power of the sediment (gel) was calculated as follows:

$$\text{Swelling Power} = \frac{\text{Wt of the wet mass of sediment}}{\text{Wt of dry matter in the gel}}$$

Emulsification Capacity (EC)

For a half minute, 2 grams of portion of the wheat flour which had been previously prepared was mixed with 25 mL of distilled water using a grinder with a stirring speed of 160 revolutions per minute. When the mixture was properly prepared, the pure maize oil was then slowly and carefully measured using a measuring cylinder and then poured into the mixture and stirred until the mixture separated into water and fat layers. This was based on the efficiency of emulsifying 2 grams of flour with a certain quantity of oil [21].

Water Absorption Capacity (WAC)

A small amount of flour that was pre-prepared (2 grams) and 25 milliliters of distilled water were swirled together for half a minute; a blender with a velocity of 160 revolutions per minute was used. After the mixture was evenly distributed, pure maize oil was slowly added to the mixture using a measuring cylinder and allowed to mix until the phases separated and formed two layers: water and fat. The formation of an emulsion was determined by the amount of oil emulsified per 2 grammes of flour [21].

Oil Absorption Capacity (OAC)

High quality maize oil (10ml) was mixed with 1g of the flour in a measured 25 or 80 ml centrifuge jar. The mixture was placed on whirling blender and then the container was stirred for 21 minutes. Interestingly, this prepared cheese was then reated at a speed of 4000 revolutions per minute for the next 20 minutes. Amount of unbound oil was followed out and noted down. Oil absorption by the flour was estimated by the amount of oil that was linked to 1 g of the dry flour [21].

Foaming Capacity (FC)

According to [21], the evaluation of foaming capacity of the flour sample was done using the following technique. 2g of the flour sample were measured and prepared by mixing it with 50 ml of distilled water at ambient temperature. The two solutions were mixed manually for 5 minutes with a rotating speed of 1000 turns per minute. The volume of the entire foaming when the outside of the nozzle was exposed to air for 30 seconds was recorded as the foaming ability.

Foaming Stability (FS)

Information on the Foam Stability (FS) of the flour packages was evaluated from the method described by [21]. Flour, in an approximate amount of 2 grams, was mixed with 50 ml distilled water with temperatures ranging from ambient to normal. The sample was then mixed for 5 mins using a maximum speed that was set at 1000 revolutions per minute. Only the overall loudness level of the signal that was obtained at the end of 30 seconds of audio input was recorded. The sample was allowed to wait for 30 mins at ambient heat and thereafter the volume of foam had been measured. Foaming stability was evaluated from the ratio of volume increase to volume at time zero after thirty seconds.

Gelation Capacity (GC)

The solution in the second try was 2. 20%, made by spotting separately 5ml filtered water in a glass separating (centrifuge) tube. The centrifuge containing the liquid was inserted in hot water bath for an hour to allow the reaction to occur. It was then quickly sluiced in cold running water for constant washing and thoroughly rinsed. In the next step, it was decided to lower the temperature of the tube to 4 degrees Celsius. The tube containing the samples was turned nucleic to observe whether the contents were balanced or not. I used the least solidification concentration which is the amount of concentration which, when added to the solution in the test tube, will prevent the mixture in the inverted tube from falling or sliding [22].

Pasting Attributes

These were analyzed through the use of a Rapid Visco Analyzer (RVA) that functions with a windows version 1. 1 thermocline. The equipment was linked to a Personal Computer system where the properties of pasting and graphs were noticed and stored instantly. An equal weight ratio of the 3 g dry specimen was mixed with purified water the total weight being 28g for RVA sample container. Each combination was maintained at 50 degrees Celsius for 1 minute and then set to 95 degrees Celsius, a rate of 12. up to a rate of 2 degrees celsius per minute and maintained there for 2. For DNA extraction, incubate the sample in a mixture of water, Triton, and salt solution at 95˚C for 5 mins. It was allowed to cool down 50°C at a rate of 11. And to find out the amount of that increase, we were instructed to cool the thermometers down by 8 degrees Celsius per minute and leave it for 2 minutes at 50 degrees Celsius [23].

Results

Influence of Germination on Functional Properties of Flour from Jack bean

The influence of germination results on the functional properties of the seed in question are reported in Table 1. The moisture uptake capability (G/g) for the processed samples ranged from 1.50± 0.01 to 1.33+ 0.01, which was greater than the raw sample (X_0) with a value of 1.10± 0.01. Oil Absorption Capability (OAC G/g) for treated samples varied from 1.35± 0.00 to 1.02± 0.01, whereas the original sample had 1.09± 0.01. The Foaming Ability (FC %) varied from 2.64+ 0.01 to 1.43+ 0.02 for processed samples and 1.71+ 0.01 for untreated sample. The Expansion Capability (SC %) for untreated sample (X_0) was 2.49 ± 0.01, but the values for processed samples varied from 3.53± 0.02 to 3.00+ 0.00. The Mass Density (G/ml) for processed samples ranged from 0.91± 0.01 to 0.79± 0.01, whereas it was 0.82 ± 0.02 for the untreated sample. The minimum solidification (cm3) was 0.28± 0.01 for processed sample and this varied from 0.34+ 0.0 to 0.17± 0.03. The P^H for processed samples ranged from 7.20± 0.02 to 6.90± 0.02, whereas it was 6.75± 0.0 for the untreated sample. The Complete Acidity Level (TTA mg/100g) for processed samples varied from 0.08 ± 0.00 to 0.07± 0.00, while the untreated sample had 0.06 ± 0.00 The brix value for untreated sample was 4.00± 0.00, while it fluctuated between 5.99± 0.01 and 4.00 ± 0.00.

Influence of Germination on Pasting Properties of Flour from Jack bean

Impact of sprouting on the viscosity parameters of Jack bean flour is outlined in Table 2. According to the data provided in the table, the Peak (RVU) values for processed samples varied from 306.01± 0.01 to 136.02 ± 0.02, whereas it stood at 111.03 ± 0.06 for the unprocessed sample. The Trough 1 values for processed samples ranged from 130.03 ± 0.06 to 90.01 ± 0.01, with a value of 77.01 ± 0.01 observed for the untreated sample.

Impact of Germination on Pasting Properties of Flour from Jack bean

The impact of germination on viscosity of Jack bean flour is outlined in Table 2. A significantly higher effect ($P < 0.05$) was observed with an average value of 306.01 ± 0.01 RVU for sample X3 during the initial peak, in comparison to the other processed samples and the untreated one. Following closely behind was sample X_5, with an average value of 225.02 ± 0.03 RVU.

Table 1: Influence of Germination on Functional Properties of Flour from Jack bean

	X0	X1	X2	X3	X4	X5
WAC (G/g)	1.10 ± 0.01^f	1.33 ± 0.01^e	1.37 ± 0.01^d	1.46 ± 0.01^c	1.48 ± 0.00^b	1.50 ± 0.01^a
OAC (G/g)	1.09 ± 0.01^c	1.02 ± 0.01^e	1.07 ± 0.01^b	1.19 ± 0.01^b	1.35 ± 0.00^a	1.35 ± 0.00^a
FC (%)	1.71 ± 0.01^e	2.64 ± 0.01^a	2.52 ± 0.01^b	2.21 ± 0.01^e	1.86 ± 0.01^d	1.43 ± 0.02^f
SC (%)	2.49 ± 0.01^f	3.53 ± 0.02^a	3.27 ± 0.06^b	3.05 ± 0.01^d	3.18 ± 0.00^c	3.00 ± 0.00^e
Bulk Density (G/ml)	0.82 ± 0.02^c	0.91 ± 0.01^a	0.91 ± 0.00^a	0.91 ± 0.00^a	0.86 ± 0.00^b	0.79 ± 0.01^d
Least Gelation (cm^3)	0.28 ± 0.01^c	0.17 ± 0.03^d	0.29 ± 0.01^{bc}	0.34 ± 0.01^a	0.32 ± 0.03^{ab}	0.30 ± 0.01^{bc}
pH	6.75 ± 0.00^e	7.00 ± 0.00^c	6.90 ± 0.01^d	7.10 ± 0.00^b	7.17 ± 0.06^a	7.20 ± 0.02^a
TTA (mg/100g)	0.06 ± 0.00^a	0.07 ± 0.00^a	0.06 ± 0.00^a	0.07 ± 0.00^a	0.07 ± 0.00^a	0.08 ± 0.00^a
Brix	4.00 ± 0.00^c	4.00 ± 0.00^c	4.99 ± 0.01^b	5.00 ± 0.00^b	5.00 ± 0.00^b	5.99 ± 0.01^a

Values stand for means of triplicate evaluations. Means with similar superscript are not significantly different at P<0.05 in the row

X_0 = Unsprouted) flour from Jack bean; X_1 = Flour from treated seed at period of 5 days; X_2 = Flour from treated seed at period of 6 days; X_3 = Flour from treated seed at period of 7 days; X_4 = Flour from treated seed at period of 8 days; X_5 = Flour from treated seed at period of 9 days

Discussion

In the present research investigation, the impact of sprouting on functional attributes of Jack bean has been summarized in the form of conclusion in Table 1. Obtained results showed that aggression exerted a significantly more substantial impact ($P < 0. 05$) with a means of 1. 50 ± 0.01. This was due to the higher WAC of sample X_5 treated in this current study compared to the other pre-treated samples and the original sample, which was observed to be nearly equal to 01. The initial sample had a mean density of 1 and the corresponding P had the lowest reading of 1. 10 + 0. 01. This feature was more evident during the germination period as shown in the Figures above. It grew from 1. 33 ± 0. Flour sample from sprouted Jack bean on day 5 in sample X_1 was 0. 50 ± 0. 01 in sample X_5. Values were higher for samples X_5 and X_4 which was a confirmation that they contained a higher protein level, which has a good influence on change of WAC of flour products [24]. WAC simply means the water absorption capacity, the ability of the powder to cause the formation of a better textured preparation in coking. In food systems, it is helpful to raise yield, texture, and structure of the food and it enhances the functions of food in emulsion systems [25].

Table 2: Influence of Germination on Pasting Properties of Flour from Jack bean

	X0	X1	X2	X3	X4	X5
Peak (RVU)	111.03 ± 0.06^{f}	136.02 ± 0.02^{e}	158.02 ± 0.02^{d}	306.01 ± 0.01^{c}	208.00 ± 0.00^{c}	225.02 ± 0.03^{b}
Trough I (RVU)	77.01 ± 0.01^{f}	113.02 ± 0.02^{d}	124.01 ± 0.02^{b}	117.01 ± 0.01^{c}	130.03 ± 0.06^{a}	90.01 ± 0.01^{e}
Break Down (RVU)	34.03 ± 0.06^{d}	23.00 ± 0.0^{e}	34.01 ± 0.01^{d}	189.03 ± 0.06^{a}	78.00 ± 0.00^{c}	135.00 ± 0.00^{b}
Final Viscosity (RVU)	104.02 ± 0.02^{f}	179.02 ± 0.02^{c}	230.00 ± 0.06^{a}	174.03 ± 0.06^{d}	207.00 ± 0.06^{b}	123.00 ± 0.01^{e}
Set Back (RVU)	27.02 ± 0.01^{f}	66.01 ± 0.01^{c}	106.00 ± 0.06^{a}	57.03 ± 0.06^{d}	77.00 ± 0.06^{b}	33.00 ± 0.06^{e}
Peak Time (mins)	5.52 ± 0.02^{e}	5.86 ± 0.01^{d}	4.86 ± 0.01^{f}	6.60 ± 0.00^{b}	6.72 ± 0.02^{a}	6.51 ± 0.02^{c}
Pasting Temp (^{0}C)	84.72 ± 0.06^{e}	95.04 ± 0.02^{a}	88.89 ± 0.02^{c}	77.50 ± 0.06^{f}	90.55 ± 0.06^{b}	87.17 ± 0.06^{d}

Values stand for means of triplicate evaluations. Means with similar superscript are not significantly different at P<0.05 in the row

X_0 = Unsprouted) flour from Jack bean; X_1 = Flour from treated seed at period of 5 days; X_2 = Flour from treated seed at period of 6 days; X_3 = Flour from treated seed at period of 7 days; X_4 = Flour from treated seed at period of 8 days; X_5 = Flour from treated seed at period of 9 days

As noted by insects, WAC is essential as it quantifies thickness and texture within contexts such as baking [26]. Samples X_4 (flour sample from sprouted Jack bean on day 8) and X_5 had comparable and pronounced higher Oil Absorption Capacity (OAC; P < 0.05), measuring 1.35 ± 0.00. On the other hand, samples X_2 (flour sample from sprouted Jack bean on day 6) and X_3 (flour sample from sprouted Jack bean on day 7) had similar significant impact, but different average values of 1.07 ± 0.01 and 1.19 ± 0.01, which were lower than the first set. With a value of 1.02+0.01, sample X_1, or the flour sample from the sprouted Jack bean on day 5, had the lowest reading. In comparison to the 207.8% reported for sunflower by [27], the OAC in the samples was lower. This might affect this sample's taste and mouthfeel, per [24]. Because hydrophobic proteins have a greater affinity for lipids, their low concentration in the sample may be the cause of its low OAC [24]. Variations in the Foaming Capacity (FC) values were caused by the germination process. Between 2.64 ± 0.01 and 1.71 ± 0.01 were the different numbers. The lowest measurement was found in the first sample. A more significant effect (P < 0.05) was seen in Sample X_1, where FC had an average value of 2.64 ± 0.01. The lowest result, 1.43 ± 0.02, was obtained by sample X_5. The flow, insertion, cum reorganisation of molecules at the flour product's air-water region control the formation of foam [28]. These values, however, are less than those that [24] reported for Bambara groundnut.

Compared to the other pre-treated samples and the raw sample, Sample X1's results showed a much higher impact (P<0.05) and an average of 3.53 ± 0.02 for Swelling Capacity (SC). Since it determines how efficiently wheat can absorb water, the swelling capacity of flour is crucial in many culinary applications [26]. 2.49 ± 0.01 was the lowest value found in the raw package. As opposed to untreated package, all of treated samples showed higher values. The bulk density increased from 0.91 ± 0.01 in sample X_1 to 0.86 ± 0.01 in sample X_4 as the sprouting day approached. In contrast to the raw sample, sample X_5 showed a decrease to 0.79 ± 0.01 indicating that sprouting could lower bulk density. Samples X_1, X_2, and X_3 showed a mean bulk density value of 0.91 ± 0.01 and a similar significant influence (P<0.05). With the exception of sample X_5, every sample showed higher values for this characteristic in comparison to the raw sample. In comparison to samples of African yam beans that had been blanched, roasted, and cooked, these values were also higher [29]. The bulk index, which is expressed in g/cm3 or g/100g, shows the weight of a unit volume of flour and serves as an indicator of structural changes. The sample results demonstrate that the flour is suitable for lowering packaging and shipping expenses [30].

Sample X_3 (flour sample from sprouted Jack bean at day 7) had the least amount of gelation (average of 0.34 $\pm$ 0.01; $P<0.05$), whereas sample X_1 (flour sample from sprouted Jack bean at day 5) had the lowest amount (071 $\pm$ 0.03). The findings of [29] are consistent with the increase in WAC, OAC, FC, SC, and bulk density along with the decrease in least gelation. Sample X_5 pH value was 7.20 $\pm$ 0.02 which is significantly ($P<0.05$) higher than the raw and other samples' values. Sample X_4 showed a substantial effect similar to sample X_5, recording the second highest average value of 7.17 $\pm$ 0.06. As the germination period extended, the acidity level increased. All of the samples were neutral in terms of acidity, with the exception of sample X_2, which had an acidic value of 6.90 $\pm$ 0.01 and the original sample (X_0), which had an acidic value of 6.75 $\pm$ 0.00. The pH values were somewhat higher than those found in the Bambara groundnut study by [24]. While the average values of Total Titratable Acidity (TTA) differed across the samples, all of them showed a similar substantial influence ($P<0.05$). Sample X_5 had the highest reported TTA value of 0.08$\pm$ 0.00, whereas samples X_4, X_3, and X_1 all had the same average value of 0.07 $\pm$ 0.00. The first sample and sample X_2 both had the lowest result, 0.06 $\pm$ 0.00. Sample X_5 had a significantly higher brix value, averaging 5.99 $\pm$ 0.01; samples X_3 and X_4 showed a comparable significant impact, averaging 5.00 $\pm$ 0.01; these values were bigger than the corresponding significant effect and average of 4.00 $\pm$ 0.00 seen in samples X_1 and X_0. As a kind of pre-processing, germination affects the functional properties of flours; this is consistent with the findings of [24] on Bambara groundnut.

Table 2 may demonstrate how sprouting affects the paste characteristics of Jack bean flour. When evaluated against other treated and the untreated samples, sample X_3, which stands for the flour sample from sprouted Jack bean on day 7, showed a significantly bigger impact ($P < 0.05$) with an average of 306.01 $\pm$ 0.01 RVU for peak I. Sample X_5, which was the flour sample from the sprouted Jack bean on day 9, came a close second with an average of 225.02 $\pm$ 0.03 RVU. Peak 1 raw sample value is the lowest, at 111.03 $\pm$ 0.06 RVU. As the sprouting time extended, this value climbed from 136.02 $\pm$ 0.02 RVU in sample X_1 (the flour sample from sprouted Jack bean on day 5) to 306.01 $\pm$ 0.01 RVU in sample X_3. This characteristic demonstrates the starch capacity to bind water and its freedom to expand prior to physical breakdown. Additionally, it demonstrates how easily the starch portion may be boiled. Sample X_3 stands out as having a larger peak, which suggests that sample X_3 has the ability to create a stable gel. As such, this sample may be appropriate for food samples that need a strong degree of gel strength and flexibility.

When compared to other samples and the raw sample, the flour sample from the sprouted Jack bean on day 8, known as Sample X_4, showed a much higher impact ($P < 0.05$), with an average of 130.03 $\pm$ 0.06 RVU for trough I. When compared to the raw sample, all of the treated samples had higher values. Out of all the processed samples, Sample X_2, which was made from sprouted Jack bean on day six, had the second-highest value of 124.01 $\pm$ 0.02 RVU. In the raw sample, the lowest value 77.01 $\pm$ 0.01 RVU was noted. Previous investigations have revealed that the sprouted kidney bean had less RVU values than the sprouted Jack bean flour [10]. Trough I shows how long wheat granules may withstand mechanical stress and high temperatures before rupturing [26]. The breakdown viscosity of the wheat samples varied significantly ($P < 0.05$). Sample X_3, which was derived from sprouted Jack bean on day 7, showed a significant effect ($P < 0.05$) in comparison to the raw sample and other treated samples, with an average value of 189.03 $\pm$ 0.06 RVU. The mean values of samples X_2 and the raw sample were 34.01 $\pm$ 0.01 and 34.03 $\pm$ 0.06 RVU, respectively, suggesting no discernible impact. A previous research [10] found that the RVU levels for samples X_3, X_4, and X_5 were more than those of germinated kidney bean. The rise in breakdown viscosity brought on by sprouting is consistent with earlier findings that some mucuna species exhibit elevated breakdown viscosity after sprouting. This demonstrates the flour's low heat and stress tolerance during cooking.

With an average of 230.00 $\pm$ 0.06 RVU for example X_2, the final thickness (i.e the change in thickness after keeping the generated starch at 50 degrees Celsius) revealed a significant impact ($P < 0.05$). Case X_4, with an average value of 207.00 $\pm$ 0.06 RVU, came a close second. With an average value of 104.02$\pm$ 0.02 RVU, all of the pre-treated cases showed higher average values than the raw example. Out of all the pre-treated instances, Example X_5 had the lowest value, at 123.00 $\pm$ 0.01 RVU. This demonstrates that the particular sample in question is able to create a stable gel, which qualifies it for uses requiring high gel strength and flexibility [31]. The final thickness indicates the starch's ability to solidify into a thick paste or gel upon cooking and cooling [33]. The setback value ranged from 106.00 ± 0.06 to 27.02 ± 0.01 (RVU), with example X_2 showing a substantial effect ($P < 0.05$) over the other examples and the raw example, which had the lowest value of 27.02 ± 0.01 RVU, with an average of 106.00 ± 0.06 RVU for this parameter. For instance, the setback value for X2 is less than the values reported by [10] for both sprouted kidney beans and cowpeas. Strong resistance to the cooked paste's retrogradation has been linked to a low setback during the chilling process [34]. When compared to other cases and the raw example, the example that sprouted for four days after the first germination symptoms had a pronounced influence ($P<0.05$) with an average value of 6.72 ± 0.02 RVU for peak period. Throughout the sprouting period, there were variations in the values obtained for this characteristic. The next-highest average for this feature, 6.60 ± 0.00 RVU, was found in Example X_3. At 5.52 + 0.02 RVU, the untreated case had the lowest value. The average RVU of example X_1 was 95.04 ± 0.02 on a significant ($p < 0.05$) basis, based on the pasting heat (gelatinization temperature), which stands for the minimal heat requirements for cooked samples [10]. Pasting temperatures observed in these cases were much greater than those seen in reports for sprouted cowpea and kidney bean [10]. This might be explained by the Jack bean flour sample having higher starch content.

Conclusion

After the investigation it was concluded that, as studies have revealed, Jack bean represents an affordable source of protein from plants. The processing characteristics (functional, pasting and nutritional) of the sprouted seeds have undergone significant modifications. Because due to sprouting, there were noticeable changes to the treated samples functional and pasting characteristics. Jack bean flour that sprouted on the fifth day had improved pasting and functional qualities. The sprouting samples might have a big impact on new product development and food fortification, especially when it comes to weaning meal composition.

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Authors Contribution

Joshua O. Odedeji: Research conceptualization, data analysis, documentation (original draft)/review, editing and final compilation.

Ramlat A. Ijale: Experimentation, sprouting, functional properties analysis.

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