EFFECTS OF STEAMING ON THE PHYSICOCHEMICAL PROPERTIES AND THE COOKING TIME OF JACK BEANS (Canavalia ensiformis)

Akande E A*, Oladipo A O and Kelani O S

Department of Food Science and Engineering, Ladoke Akintola University of Technology, Ogbomoso, (+ 234), Nigeria.

Received – October 21, 2013; Revision – November 15, 2013; Accepted – December 06, 2013
Available Online December 30, 2013.

ABSTRACT

The potentials of jack beans (Canavalia ensiformis) for consumption and product development have been on the low side because of its peculiar nature, beany flavor and long cooking time. Present study has been taken in the hand for finding out the effects of steaming on the physicochemical properties and cooking time of Jack beans in order to establish the optimum steaming temperature and time combination for the processing. Three samples of beans were steamed on 120psi at time intervals of 15, 30 and 45mins, control was without steamed. These samples were analyzed for difference qualities like the physical characteristics, chemical composition, as well as the proximate composition using standard methods. The physicochemical properties obtained showed bulk density ranged from 0.716g/ml - 0.762g/ml, percentage gelation strength ranged between 10.00 - 18.00%, water absorption capacity between 2.6ml/g to 3.0ml/g, pH range between 6.42 - 6.44 and the titratable acidity between 2.55g/100g - 2.80g/100g. The proximate composition showed the percentage moisture content ranges between 7.25% - 9.0%, ash content between 2.43% - 2.73%, protein content between 21.0% - 24.3%, fat content between 3.48% - 3.76% and carbohydrate content between 54.30% and 56.67%. The cooking time varies from sample A to B at the range of 30 to 45 minutes respectively. The overall results of the research suggest that Jack beans can be subjected to steaming time of 45 minutes for adequate nutrient detainment and minimum cooking time.

* Corresponding author
E-mail: eaakande@lauotech.edu.ng (Akande E A)

Peer review under responsibility of Journal of Experimental Biology and Agricultural Sciences.
1 Introduction

Fruit of leguminous tree are versatile and nutritious foods with low fat, cholesterol and are high in folate, potassium, iron and magnesium level. Fruits also contained soluble and insoluble beneficial fats and fiber. Fruit serve as a source of protein and can be serve as an alternate source of meats with high amount of fats and cholesterol. Jack-bean (Canavalia ensiformis) is a tropical leguminous plant with high seed and herbage yields and there is no stiff competition between humans and livestock industries in its use. Seeds and herbage of tree are rich in protein and mineral elements such as Calcium, Zinc, Phosphorous, Magnesium and Copper (Udedibie & Nkwocha, 1990). Presence of some anti-nutrients like protease inhibitors, haemagglutinins, cyanogenic glycosides, tannins, phytates, conavanine, oxalates ( Apata & Ologbobo, 1989; Carlini & Udedibie, 1997) was also reported from the seeds of Jack been.

Overwhelming evidence of scientific research shows that eating a wholegrain and high fiber foods made from legumes helps to prevent and manage various diseases like diabetes, constipation, high blood pressure and anemia. As a result of the established nutritional benefits or attributes associated with jack beans which are underutilized, it will be appropriate to exploit the beans for the various food applications. However, the peculiar nutritional complexity and long cooking time associated with the beans has been a major constraint. Therefore, subjecting the beans to pre-processing condition like steaming will assist a lot. Hence, the aim of this research is to investigate the effects of steaming on the physicochemical properties and the cooking time of the beans.

2 Materials and Methods

Jack bean seeds were procured from experimental farm of Osun State Polytechnic, Iree. The equipment and chemicals utilized were of food grade and analytical standard, all obtained from the Department of Food Science and Engineering Laboratory, Ladoke Akintola University of Technology, Ogbomoso.

2.1 Sample Preparation

1kg of Jack beans was weighed and divided into four equal parts (200g each). One part of seeds was taken as the control and the rest parts were steamed- as pretreatments in the pressure cooker. The set up was put at 120psi maintained for 15, 30, and 45 minutes. The samples were then milled to fine particles, packaged into transparent cellophane nylons and labeled as Samples A, B, C, D (the Control Sample) for further analyses. Portion of each of the samples were each subjected to cooking to determined their respective cooking time.

2.2 Analysis

The various analyses carried out on the samples include: physicochemical, proximate and cooking time measurement

2.2.1 Physicochemical Analysis

Physicochemical analyses were carried out by the method described in AOAC (1990). It includes bulk density, water absorption capacity, gel strength, pH and total titratable acidity.

2.2.2 Proximate Analysis

The proximate analysis was carried out as method described in AOAC (1990). The moisture content was determined by oven drying method, ash Content by the use of muffle furnace, crude fat was determined by using solvent extraction (Petroleum ether) and the crude fiber was obtained using the standard digestion method. The total Nitrogen was determined by Kjehdal method and the value multiplied by 6.25 to obtain the actual protein content.

2.3 Cooking time

The various samples were subjected to cooking by used the electric cooker regulated at 100°C. The samples were checked for degree of softness using penetrometer and the cooking time in each case was noted.

3 Results and Discussion

The effects of steaming on the physicochemical properties of jackbeans were mentioned in table 1. The bulk density of the cooked jack bean was reported between 0.716 ±0.01g/ml - 0.762±0.01g/ml while the gel strength ranged between 10% -18% and water absorption capacity ranged between 2.6±0.00- 3.0±0.00ml/g. Similarly the pH value of steamed bean has been increased from 6.415±0.01 to 6.44±0.00. The total titratable acidity ranged from 2.550±0.01g/100g to 2.795±0.01g/100g. Bulk density is the weight per overall unit volume of a substance used in particular for porous substances where density is affected by pore volume and can be increased by the presence of pore fluid (Carlini & Udedibie, 1997). The result of the bulk density showed that the Control (un steamed beans) has the highest value (0.7615g/ml) and this value decreases gradually with the increasing of temperature and it was highest in the 45 minute steaming i.e. 0.7155g/ml. The bulk density of the sample decreases as the steaming time increases because increasing steaming time equally decreases the porosity of the sample after processing.

Gelation is the process of gel formation by coagulation of sols or aggregation of particles. It is caused by formation of intermolecular cross-links during heating or cooling. Aggregation of particles may be induced by a variety of stimuli including changes in pH or ionic strength. The ability of gelatin solutions to form a gel is the attributes that accounts for the major uses of gelatin. The gelation strength of the samples are as shown in the table 1; Gel strength for the Control was found 18% and it is decreases with the increasing in steaming.
time of and it was reported lowest i.e. 10% in the sample steamed for 45 minutes. This result showed that increased steaming time breaks or destroys the gel formation (Adelakun, 2009).

Water absorption capacity is the property of a substance that determines the extent to which it can bind with water. This property determines to some extent the rate at which rancidity occurs in food. Chemicals used to increase this property include salts like sodium nitrate or sodium nitrite, sweeteners and some curing agents. The water absorption capacity of the samples as shown in Table 1 signifies that increased steaming time enhances this property as a result of the solubility of the samples. The control had lowest value of water absorption (2.6 ml/g) while it was reported highest in the sample cooked for 45 min steamed (3.0ml/g).

The pH has an important effect on the rapidity with which browning occurs. Acid drips are sometimes used to lower the pH and by this method delay or retard browning and also sometimes disturb microbial degradation of foods. The pH values as shown in the Table 1 revealed that the Control is more acidic as compared to the steamed bean. So, un cooked eating of the bean can cause gastro-intestinal tract disorder, this discovery by early researches is related to the most likable reason why it is less consumed (Badifu, 2001; Audrey et al, 2004; Emily et al, 2009). When the bean processed, the pH value increased from 6.415 to 6.440 and there is still tendency that further pre-treatment like cooking will neutralize the acidity and make it safe for consumption.

The total titratable acidity as shown in the table indicates that as the steaming time increases, the acidity of the sample reduces. The proximate composition of the different samples of *Canavalia ensiformis* has shown in Table 2. The ash contents ranged between 2.43±0.025 - 2.73±0.050%. The fat content ranged was reported from 3.48±0.020 - 3.76±0.020%. The total moisture content was ranged from 7.25±0.050% - 9.0±0.001%. The crude fiber content ranged from 8.87±0.05 - 7.14±0.02%. The protein content of jack bean seeds ranged from 21.0±0.1 - 24.3±0.1% and the carbohydrate amount ranged from 54.30±0.100 % - 56.67±0.1%. All these values are within the range of processed legumes; moisture 7.15-9.43%, crude protein 22.53-24.00%, crude fat 3.50-3.99%, crude fibre 6.95-8.82%, ash 2.24-3.80%, and carbohydrate 54.95-58.98 % (Pearson, 1973).

Moisture content of bean determines the shelf life of substance the type of environmental conditions with which the sample can be kept. The moisture content of the sample increased with the steaming time which implies that the percentage of moisture of the samples is a function of the time of exposure to steam. Sample A has the lowest moisture content (7.25%) was reported from the jack bean seeds while highest steaming time had highest value (9.0%). These values are within the range of most processed legumes 9 (Ihekonye & Ngoddy, 1985).

The ash content contained the mineral elements in foods and it was reported that ash of bean contains high amount of iron, calcium, selenium, and iodine. These minerals play a major role in maintenance of health in man and are needed in small quantity. The ash content reduce with increasing steaming time (2.725% to 2.43%) showing that the some minerals present in the sample might have been affected by moisture migration or kinetics with increase in temperature.

The percentage crude fibre which is the indigestible matter left in foods after successive digestion with ether, acids and alkalis, and subtraction of ash. It is commonly determined as part of the proximate composition of foods. Values are usually reported in relative values and not as exact dietary fiber of foods. The obtained signifies that increased steaming time reduces the crude fibre present in the sample.

The crude fat present in the sample is found to increase with increase in the steaming time. The fat content of legumes are found located in the cotyledon and steaming exposes the fat present making it available for extraction and so the more the steaming time (at constant temperature), the more crude fat available. The percentage crude protein in the sample is said to decrease with steaming time. This may be as a result of evaporation of some soluble nitrogenous compounds during the process of steaming.

### Table 1 Physicochemical properties of Jack beans at various steaming time.

<table>
<thead>
<tr>
<th>Samples</th>
<th>pH</th>
<th>TTA</th>
<th>BD (g/ml)</th>
<th>GS (%)</th>
<th>WAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>un steamed</td>
<td>0.762±0.01</td>
<td>18.000±0.00</td>
<td>2.600±0.00</td>
<td>6.415±0.01</td>
<td>2.795±0.01</td>
</tr>
<tr>
<td>15 m Steamed</td>
<td>0.747±0.00</td>
<td>14.000±0.00</td>
<td>2.700±0.00</td>
<td>6.415±0.01</td>
<td>2.785±0.01</td>
</tr>
<tr>
<td>30 m Steamed</td>
<td>0.734±0.01</td>
<td>12.000±0.00</td>
<td>2.800±0.00</td>
<td>6.430±0.00</td>
<td>2.745±0.01</td>
</tr>
<tr>
<td>45 m Steamed</td>
<td>0.716±0.01</td>
<td>10.000±0.00</td>
<td>3.000±0.00</td>
<td>6.440±0.00</td>
<td>2.550±0.01</td>
</tr>
</tbody>
</table>

KEY: BD= Bulk Density; GS= Gel Strength; WAC= Water Absorption Capacity; pH= Hydrogen ion Concentration; TTA= Total Titratable Acidity ± mean standard error of three replicates.
Table 2 Proximate composition of Jack beans at various steaming time.

<table>
<thead>
<tr>
<th>Samples</th>
<th>M.C (Moisture Content)</th>
<th>A. C (Ash Content)</th>
<th>C.F (Crude Fibre)</th>
<th>C. Ft (Crude Fat)</th>
<th>C.P (Crude Protein)</th>
<th>Carbohydrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Un steamed</td>
<td>7.25±0.10</td>
<td>2.73±0.10</td>
<td>8.87±0.10</td>
<td>3.48±0.02</td>
<td>24.30±0.10</td>
<td>55.37±0.10</td>
</tr>
<tr>
<td>15 m steaming</td>
<td>8.05±0.10</td>
<td>2.68±0.01</td>
<td>8.71±0.02</td>
<td>3.56±0.02</td>
<td>22.70±0.10</td>
<td>54.30±0.10</td>
</tr>
<tr>
<td>30 m steaming</td>
<td>8.80±0.00</td>
<td>2.54±0.10</td>
<td>7.67±0.02</td>
<td>3.65±0.02</td>
<td>22.00±0.10</td>
<td>55.34±0.10</td>
</tr>
<tr>
<td>45 m steaming</td>
<td>9.00±0.00</td>
<td>2.43±0.02</td>
<td>7.14±0.02</td>
<td>3.76±0.02</td>
<td>21.00±0.10</td>
<td>56.67±0.10</td>
</tr>
</tbody>
</table>

M.C (Moisture Content); A.C (Ash Content); C.F (Crude Fibre); C. Ft (Crude Fat); C.P (Crude Protein); ± mean standard error of three replicates.

Table 3 Effect of steaming on the cooking time of Jack beans.

<table>
<thead>
<tr>
<th>Samples</th>
<th>Penetrometer readings (m/s)</th>
<th>Cooking time (Mins)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.017</td>
<td>120.00</td>
</tr>
<tr>
<td>15 m steaming</td>
<td>0.014</td>
<td>70.00</td>
</tr>
<tr>
<td>30 m steaming</td>
<td>0.013</td>
<td>60.00</td>
</tr>
<tr>
<td>45 m steaming</td>
<td>0.011</td>
<td>45.00</td>
</tr>
</tbody>
</table>

The effects of steaming time on the cooking time of jack beans were as presented in table 2. Cooking is the total minimum time utilized in the attainment of the best texture (in term of softness) of food materials for consumption. This was established on the basis of the rate of penetrability of the beans with steaming time. The rate of penetration measured ranges from 0.015m/s (highest) to 0.017m/s (Minimum). At the penetration of 0.0017 m/s, the cooking time is 120.00minutes. Subsequent value shows that there is the corresponding reduction in the cooking time with shorter penetration rate. The minimum cooking time was attained at the penetration of 0.001m/s. This indicates that the cooking time is attained at 120psi for 45 minutes.

Conclusion

Steaming is an effective pretreatment for the preparation of Jack beans (C. ensiformis) and most grains which equally reduces cooking time and retains the inherent nutrients present in the legumes. In present study, 45 min steaming time at 120psi was found to be most appropriate time because, it had highest percentage of nutrients retention which is the reason for consumption of most staple foods. In addition to this, the treatment is found to save energy and time of cooking.

Reference


Pearson D (1973) Laboratory Technique in Food Analysis, Wiley Publication,USA.

Udedibie ABI, Nkwocha CO (1990), Comparative study of Jack-bean (Canavalia ensiformis) and swordbean (Canavalia gladiata) as protein supplements for young broiler chicks. Nigerian Agricultural Journal 24: 7-14.