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Tenderizing Effect of *Allium cepa* on Proximate Composition of *Phaseolus vulgaris*

Victor Duniya SHENENI[1]*, Theophilus Boniface MOMOH[2], Emmanuel EDEGBO[3]

[1]Department of Biochemistry, Kogi State University, Ayingba, Nigeria
[2]Department of Biological Sciences, Kogi State University, Ayingba, Nigeria
[3]Department of Microbiology, Kogi State University, Ayingba, Nigeria
*Corresponding author: **Sheneni, Victor Duniya.**
Department of Biochemistry, Faculty of Natural Sciences, Kogi State University, PMB 1008, Anyigba, Nigeria, Tel: +234- 8033519009;
E- mail: *shenenivictor@gmail.com*

Abstract

Phaseolus vulgaris (Beans) was cooked with 0, 20, 40, 60 and 80 g of *Allium cepa* (Onion) after which twenty-one (21) people felt the texture of the cooked whole grains with their bare hands using the thumb and index finger, and thereafter rated the degree of tenderness of each sample in comparison with the control sample. Proximate analysis was carried out on each of the samples. The results were analysed using Pearson chi–square tests and analyses of variance. The tenderizing effect of *Allium cepa* was most felt at weight 60g and 80g. There was an increase in the moisture content (53.39 % - 57.01 %), Ash (1.5 % - 2.85 %), Fibre (0.25 -1.17 %), Fat (5.07 % - 6.65 %) and Carbohydrate (21.39 – 22.39 %) with increase in concentration of *Allium cepa*. Protein decreased gradually from 17.99 – 9.94 %. The effect on the proximal components was significant at ($p<0.05$). The study showed that *Allium cepa* can be used to tenderize *Phaseolus vulgaris* when added at a considerably high amount.

Keywords: *Allium cepa*, *Phaseolus vulgaris*, Tenderizing Effect.

Introduction

Onion plant is an herbaceous biennial plant in the family Alliaceae or Liliaceae which is grown for its edible bulb. Other members belonging to the same family include shallot (*Allium cepa* L. var. aggregatum G. Don.), common garlic (*A. sativum* L.), leek (*A. ampeloprasum* L. var. porrum L.) and chive (*A. schoenoprasum* L.) (Griffiths *et al.*, 2002).

According to Hasegawa *et al.*, (2001) onions originated from central Asia, and are cultivated in many countries around the world. In terms of income onions are the second most important vegetable crop after tomatoes in the world (Griffiths *et al.*, 2002; Mallor *et al.*, 2011). In South Africa, onions are considered to be the third most important vegetable crop after potatoes and tomatoes (Department of Agriculture, Forestry and Fisheries, 2010; The National Agricultural Directory, 2011).

Onion plants can reach a height of 50cm and are grown as annuals, harvested after one growing season. *Allium cepa* has fibrous roots (Ranjitkar, 2003), it is an underground stem modified into tunicated bulb consisting of reduced stem and axillary buds surrounded by inner fleshy scale leaves and outer membranous dry scales (Ranjitkar, 2003). The stem is a flattened disc at the base of the plant and occurs below the soil surface (Brewster, 2008). At the centre of the stem, new leaves and roots are produced. Each leaf is made up of a blade and sheath. It is the leaf sheath that appears to be the stem of the plant above the soil level (Brewster, 2008). As the leaf sheath develops, it surrounds the growing point and forms a tube enclosing the young developing leaves (Brewster, 2008). The bulb is protected by a membrane which turns to a paper coat. The bulbs are uniform in shape, size and skin colour, the shapes ranges from spherical to nearly cylindrical and include flat and cone like bulbs. Skin variation varies which may be white, yellow, and brown, red or purple (Ross, 2001). Colour is a key breeding trait in onion, both for the visual appeal to customers and the increasing association between plant pigments and human health benefits (Martin *et al.*, 2011; Davis and Espley, 2013). The umbel is an aggregate of flowers at various stages of development; usually, it consists of 200-600 small individual flowers (Ross, 2001). The flowers of Allium cepa are bracteates, consisting of bracts and spathe. Two to three membranous spathe-like bracts enclose the flower during young stage. They are actinomorphic, hypogynous, small and white (Ranjitkar, 2003). The androecium consists of six stamens in two whorls of three each opposite the sepals; they are antipetalous, polyandrous, epiphyllous and inferior. The filaments are long but slightly dilated at the base, the anther is long, bilobed and basifixed (Ranjitkar, 2003). The gynoecium is tricarpellary and syncarpous. The ovary is a superior ovary, it is trilocular with two ovules in each locules. It exhibits axile placentation. The style is short and filiform with minute stigma (Ranjitkar, 2003).

Onion provides flavour, colour and texture to a wide variety of dishes. But much more than the flavour, the health benefits of onion makes it highly significant in human health. While onions are not particularly high in most nutrients, they contain anti-inflammatory, anti–cholesterol, anti–cancer and antioxidant components such as quercetin (GMF, 2007). Fisetin, a flavonoid found in onion has a great role in treating chronic diseases (Pearlman, 2016). Onions are rich in vitamin C and in Chromium; a trace mineral tied to insulin response (GMF, 2007). Quercetin is known for its antibacterial and antioxidant activities (Ramos *et al.*, 2006). Steak or tough meat when soaked in onion juice before cooking was found to become tender (Volhina, 2012).

Beans (*Phaseolus vulgaris*) are native to the New World, probably Central Mexico and Guatemala. They were taken to Europe by the Spaniards and Portuguese who also took them to Africa and other parts of the Old World. Now they are widely cultivated in the tropics, subtropics and temperate regions. Roughly 30% of world production is in Latin America. They are less known in India, where other pulses are preferred (CIAT. 1974).

Phaseolus vulgaris is a highly polymorphic species; annual herb, erect and bushy, 20–60 cm tall, or twining with stems 2–3 m long; with a taproot and nitrogenous nodules; (although the germinating bean has a tap root, adventitious roots usually emerge 1–2 days after germination, to dominate the tap root which remains 10–15 cm long); leaves alternate, green or purple, trifoliolate, stipulate, petiolate, a marked pulvinus at base; leaflets ovate, entire; acuminate, 6–15 cm long, 3–11 cm wide; flowers in lax, axillary few-flowered (12) racemes, zygomorphic, variegated, white, pink, or purplish, ca 1 cm long; pods slender, green, yellow, black, or purple, cylindrical or flat, 8–20 cm long, 1–1.5 cm wide; seeds 4–6-(12), usually glabrous, sometimes puberulent, beak prominent; seeds white, red, tan, purple, grey or black, often variegated, reniform, oblong or globose, up to 1.5 cm long, endosperm absent; 100 seeds weigh 10–67 g, depending on cv; germination phanerocotylar (Adams 1980).

Beans are most widely cultivated of all beans in temperate regions, and widely cultivated in semitropical regions. In temperate regions the green immature pods are cooked and eaten as a vegetable. Immature pods are marketed fresh, frozen or canned, whole, cut or french-cut. Mature ripe beans, variously called navy beans, white beans, northern beans, or pea beans, are widely consumed. In lower latitudes, dry beans furnish a large portion of the protein needs of low and middle class families. In some parts of the tropics leaves are used as a pot-herb, and to a lesser extent the green-shelled beans are eaten. In Java, young leaves are eaten as a salad. After beans are harvested, straw is used for fodder. Beans are said to be used for acne, bladder, burns, cardiac, carminative, depurative, diabetes, diarrhea, diuretic, dropsy,

dysentery, eczema, emolient, hiccups, itch, kidney, resolvent, rheumatism, sciatica, and tenesmus (James 1999).

Materials and Methods

Materials

Study Area

Anyigba where the study was conducted is one of the villages in Dekina Local Government Area, Kogi State, North-Central Nigeria with a population of about 71, 327 according to 2006 National Census. Anyigba is located on Latitude 7'31" N and Longitude 1'12" E, with a total area of 11.07506 Sq km (Town Planning Development Board, 2002). Anyigba is inhabited by Igala, Ebira and Bassa alongside with people from other ethnic groups in Nigeria such the Yoruba, Igbo, Hausa, Idoma e.t.c. as well as foreign nationals. The climatic condition is tropical continental with a distinct wet and dry season. The rainy season occurs from April to October and the dry season from November to April.

Collection of Materials

The food items; iron beans, onions, fresh pepper and palm oil were purchased from the market in Anyigba (Unity square). These items and other cooking materials such as kerosene, stoves and water were moved to Biological sciences laboratory, Kogi State University, Anyigba.

Sample Preparation

The beans were poured into a bowl where the bad ones, dirt, sand and stones were removed. 500g of beans (2 cups) were measured into five different plastic containers and onion bulbs were peeled and sliced with a knife in a flat plate. Fresh pepper was also washed and blended with a manual blender. 20g, 40g, 60g and 80g of onions were measured using electric weighing balance and transferred into beakers which were appropriately labelled. The beans were washed with water and drained in sieves. The five stoves were arranged on the workbench and lit. Five pots containing about one litre of water each were covered and arranged on the stoves and heated until the water boiled after which the drained beans were introduced into each of the boiling water for all the five stoves. 20g, 40g, 60g, and 80g of onions were introduced into the second, third, fourth and fifth pots respectively with no onion in the first stove (Control). Each cooking set-up was carefully labelled; control (0g), 20g, 40g, 60g and 80g respectively with a masking tape using ink marker. Forty minutes later, 4g of fresh pepper, 4g of seasoning cube, 6g of salt, 10g of palm oil were introduced into each of the five set-ups. Thereafter, the set-ups were covered and allowed to cook for about thirty more minutes after which all the stoves were put off.

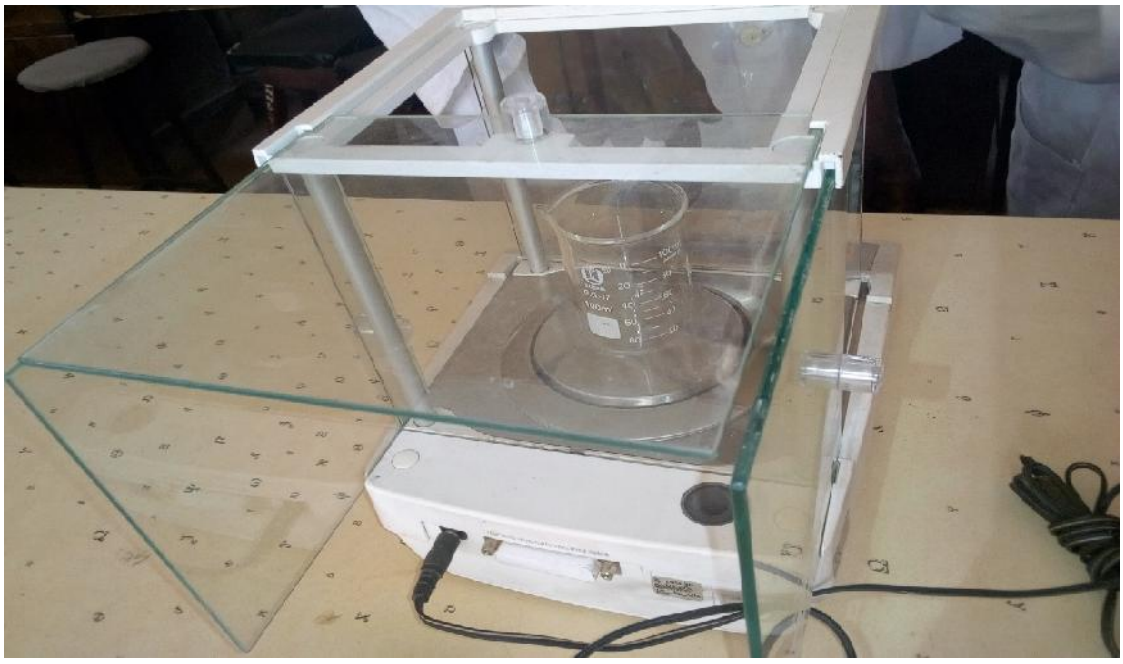

Plate 1: Electric weighing balance

Plate 2: Sliced *Allium cepa* (onions)

Plate 3: Cooking set-ups

Methods

Tenderizing Effect of samples

A qualitative approach was employed here (questionnaire). The same quantity of the food sample was put into five petri dishes in the order of arrangement of the samples, (0g, 20g, 40g, 60g and 80g). Twenty one people were made to feel the texture of each food sample with their hands (thumb and index), each in comparison with the control sample (0g). The respondents were then asked to judge or rate the degree of tenderness of each sample in comparison with the control sample to know whether there is no difference, moderate difference or much difference. At the end of this exercise, the total number of responses for various degrees of effect of onions on the tenderness of each sample were analyzed and tabulated.

Plate 4: Cooked Samples of *Phaseolus vulgaris* with 0g, 20g, 40g, 60g and 80g of *Allium cepa* in air–tight containers.

Proximate Analysis of Samples

After cooling, samples were gotten from each of the five pots and put into plastic air-tight containers and further allowed to cool before refrigerating for about seven hours. Proximate analysis was carried out in Biochemistry Laboratory of Kogi State University, Anyigba using the methods described in Association of Official Analytical Chemist (AOAC, 2010).

Data Analysis

Statistical analysis of the data obtained from the respondents for tenderness test and the result from proximate analysis of samples was performed using the Statistical Package for Social Sciences (SPSS) version 20. Pearson's Chi–square test was performed where appropriate to identify any effect of *Allium cepa* on *Phaseolus vulgaris*. The level of significance of each test was set at p-value less than 0.05 ($p < 0.05$).

Results

Tenderizing effect of *Allium cepa* on the different treatment categories of *Phaseolus vulgaris* in comparison with the control

Table1 shows the result of comparison of tenderness carried out by twenty-one (21) people between *Phaseolus vulgaris* cooked with 20g and 0g of *Allium cepa.* The result showed that there was no significant difference in the degree of tenderness between the control sample and the sample with 20g of onion ($\chi^2 = 1.714$, d.f = 2, p value > 0.05).

Table1: Degree of tenderness between 20g and Control

Degree of effect	20 g	Control	Total
No Difference	7 (33.3 %)	14 (66.7%)	21 (100%)
Moderate Difference	9 (42.9 %)	12 (57.1 %)	
Much Difference	5 (23.8 %)	16 (76.2 %)	
Chi-square	1.714		
d.f	2		
P value	0.424		

Table 2 shows the result of comparison of tenderness carried out by twenty-one (21) people between *Phaseolus vulgaris* cooked with 40g and 0g of *Allium cepa.* The result showed that there was no significant difference in the degree of tenderness between the control sample and the sample with 40g of onion (χ^2 = 5.143, d.f = 2, p value > 0.05).

Table 2: Degree of Tenderness between 40g and control

Degree of effect	40g	Control	Total
No Difference	5 (23.8 %)	14 (76 %)	21(100 %)
Moderate Difference	11 (52.4 %)	10 (47.6 %)	
Much Difference	5 (23.8 %)	14 (76.2 %)	
Chi – square	5.143		
d.f	2		
P value	0.76		

Table 3 shows the result of comparison of tenderness carried out by twenty-one (21) people between *Phaseolus vulgaris* cooked with 60g and 0g of *Allium cepa.* The result showed that there was significant difference in the degree of tenderness between the control sample and the sample with 60g of onion (χ^2= 0.032, df = 2p value <.05).

Table 3: Degree of Tenderness between 60g and Control

Degree of Effect	60g	Control	Total
No Difference	3 (14.3 %)	18 (85.7 %)	21
Moderate Difference	11 (52.4 %)	10 (47.6 %)	
Much Difference	7 (33.3 %)	14 (66.7%)	
Chi – square	6.857		
d.f	2		
P value	0.032*		

Table 4 shows the result of comparison of tenderness carried out by twenty-one (21) people between *Phaseolus vulgaris* cooked with 80g and 0g of *Allium cepa.* The result showed that there was significant difference in the degree of tenderness between the control sample and the sample with 80g of onion (χ^2 = 0.011, d.f = 2, p value <0.05).

Table 4: Degree of Tenderness between 80g and control

Degree of Effect	80g	Control Total
No Difference	6 (28.6 %)	21(100%)
Moderate Difference	12 (57.1 %)	
Much Difference	3 (14.3 %)	
Chi – square	9.00	
d.f	2	
P value	0.011*	

The tenderizing effect of onion became significant and notable as the concentration of onions increased. In sample 20g, the onions had no tenderizing effect on the sample. The sample was not tenderer than the control sample with 0g of onion. With 40g of onions, the effect on tenderness of the food sample was not significant whereas, there was significant difference in the level of tenderness of the samples that contain 60g and 80g of onions when compared with the control sample.

Proximate Analysis

Table 5 shows the results of the proximate composition of cooked *Phaseolus vulgaris* samples with varied quantity of onions. The result showed that there was significant difference in the proximate composition of samples with increasing onion concentrations except for protein which decreased steadily with increase in onions at p value < 0.05.

Table 5: proximate composition of cooked *Phaseolus vulgaris* samples with varied quantity of onions.

Treatments	% Moisture	% Ash Content	% Crude Fibre	% Fat	% Protein	% CHO
Control	53.39±0.02^{e}	1.53±0.03^{e}	0.25±0.05^{d}	5.07±0.03^{e}	17.99±0.04^{a}	21.79±0.02^{b}
20g	56.05±0.05^{c}	1.70±0.00^{d}	0.52±0.02^{c}	5.45±0.05^{d}	17.06±0.00^{b}	19.22±0.12^{d}
40g	56.40±0.00^{b}	2.15±0.05^{c}	0.74±0.00^{b}	5.80±0.00^{c}	14.57±0.04^{c}	20.34±0.09^{c}
60g	56.87±0.07^{a}	2.48±0.02^{b}	0.81±0.01^{b}	6.17±0.03^{b}	11.90±0.09^{d}	21.78±0.10^{b}
80g	57.01±0.01^{a}	2.85±0.05^{a}	1.17±0.03^{a}	6.65±0.05^{a}	9.94±0.04^{e}	22.39±0.04^{a}
Total	55.94±0.44	2.14±0.16	0.70±0.10	5.83±0.18	14.29±1.01	21.10±0.39
p-Value	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*

Discussion

The results of the effect of onions on the degree of tenderness of the food samples showed that onions has tenderizing effect on *Phaseolus vulgaris* only at high concentration. Samples with low concentration of onions showed no significant difference in the degree of tenderness in comparison with the control sample at p value <0.05. The observation is in line with the tenderizing effect of onions on tough meat observed by Volhina in 2012 after soaking in onions juice before cooking. Proximate analysis of the samples revealed a steady increase in most of the proximate components of the food samples except for protein which decreased with increase in the concentration of onions added. This gradual decrease in protein concentration with increase in onions may be due to the nutrient chemicals (tannin, saponin and cyanogenic glycoside) present in onions (Nwinuka*et al.*, 2005). Tannins had been shown to possess protein binding capacity which is also responsible for protein loss (Dawra *et al.*, 1988). These anti-nutrients are chemicals which are produced for the defence of the plant among other biological functions, they reduce maximum utilization of nutrients especially proteins, vitamins and minerals. Some of these plant chemicals have been shown to be

deleterious to health or evidentially advantageous to human and animal health if consumed at appropriate amounts (Ugwu and Oranye, 2006). Anti-nutrients in plant foods are responsible for deleterious effects related to the absorption of nutrients and micronutrients (Ugwu and Oranye, 2006). However, some anti-nutrients may exert beneficial health effects at low concentrations. For example phytic acid, tannins, saponins and protease inhibitors have been shown to reduce the availability of nutrients and cause growth inhibition. At low levels phytate, tannins, and saponins have also been shown to reduce the blood glucose and insulin responses to starchy foods and the plasma cholesterol and triglycerides (Ugwu and Oranye, 2006). This implies that anti-nutrients might not always be harmful. Despite the result obtained from this study, the balance between beneficial and hazardous effects of plant bioactives and anti-nutrients rely on their concentration, chemical structure, time of exposure and interaction with other dietary components. Due to this, they can be considered as anti-nutritional factors with negative effects or non-nutritive compounds with positive effects on health (Habtamu and Negussie, 2014).

The increase in the moisture content indicates the help onions supplies to the body in digestion of food as the body uses less energy and resources to digest and can assimilate all nutrients much faster. Less pressure is therefore put on the digestive system (Kwenin *et al.,* 2011). There was a gradual increase in the ash content of the samples with increase in the quantity of onions added. The study of ash content provides an insight into the nutritionally important mineral elements which includes Calcium, phosphorus, potassium, iron, sodium, zinc, manganese and copper (Shovon*et al.* 2013). It was reported that the ash content of a food sample gives an idea of the mineral elements present in food samples (Edeogu *et al.,* 2007).

A steady increase in the fibre content as the quantity of onions increase in the food samples was noticed. Crude fibre is increasingly being recognized as a useful tool for the control of oxidative processes in food products and as functional food ingredient. The presence of crude fibre in the diet is necessary for digestion and for elimination of wastes (Shovon *et al.,* 2013). Crude fibre also functions in the protection against cardiovascular disease, colorectal cancer and obesity. Thus high consumption of onions in food is useful in the management of diabetes mellitus, colorectal cancers and weight reduction in obsessed individuals (Shovon *et al.,* 2013). The levels of protein were found to be inversely proportional to the rate of increase in onion. That is, protein level decreased as onions concentration increased in the food samples. The increase in carbohydrate and fat content noticed with increase in onions concentration in the food samples shows the significant role of onions in human health. This is in line with the work of Nwinuka *et al.,* (2005) which showed that onions are a good source of carbohydrate.

Conclusion

The study provides evidence that *Allium cepa* has a tenderizing effect on *Phaseolus vulgaris* at a considerably high concentration, thus validating the use of *Allium cepa* as a tenderizing agent at high concentrations. Also the study had shown that *Allium cepa* may have an increase effect in proximate compositions of food samples. The use of *Allium cepa* as a tenderizing agent for food samples is thus recommended especially for *Phaseolus vulgaris.*

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