

# FUNCTIONAL PROPERTIES OF SOYBEAN AND LOCUSTBEAN DAWADAWA; A BACTERIAL FERMENTED PRODUCT

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## ABSTRACT

Functional properties of soybean and locustbean dawadawa; a bacterial fermented product, were investigated. Locustbean and soybean seeds were processed and fermented for 48h and the products; dawadawa, assayed for gelation capacity, water and oil absorption capacity, emulsion capacity and emulsion stability. Results showed that water absorption capacity (WAC) of fermented soybean increased significantly ( $P < 0.05$ ), while fermentation decreased the WAC of locustbean. Also, there was a significant reduction in the oil retention capacity of fermented products.

Fermentation caused a considerable reduction in the emulsification capacity of soybean dawadawa. Locustbean dawadawa had least gelation concentration at 30% (W/V). Dawadawa though a seasoning could be used in food systems where some modification in the functionality of the inherent basic ingredient is required, as in some Nigeria soups.

**Key Words:** Soybean, locustbean, fermentation, functional properties, dawadawa.

## INTRODUCTION

Protein rich seeds such as oil bean, melon seed, castor seed, African locustbean (*Parkia biglobosa*) and soybean (*Glycine max*) are often fermented to make food condiments. The use of hydrolysed vegetable protein as seasoning has long been recognized (Odunfa, 1986). Dawadawa is by far the most important food condiment in West and Central Africa (Campbell-Platt, 1980). It is also used as a low cost meat substitute by poor families (Simmons, 1970). Dawadawa is traditionally produced from solid state fermentation of locustbean (*Parkia biglobosa*). However, due to the increasing scarcity and cost of locustbean seed, there has been a gradual shift to the use of soybean for dawadawa production (Mebrahtu and Hahn, 1986).

Functional properties of protein are those physicochemical properties that govern the behaviour of protein in food systems (Kinsella, 1985). Functionally is related to the interaction of the proteins with the ingredients or processing conditions in food systems (Lawson, 1994). Increased understanding of the physicochemical, nutritional and functional characteristics of soybean and locustbean dawadawa will enhance their potential as an ingredients in protein fortified foods. Utilizing plant protein as functional ingredients depend largely on the beneficial qualities they contribute (McWatters and Cherry, 1977). Currently published literature is lacking on the functional properties of dawadawa. Our objective was to investigate the functional

properties of soybean and locustbean dawadawa; a bacterial fermented product.

## MATERIALS AND METHODS

Locustbean seed was purchased from a local market at Ibadan, while soybean was obtained from the international institute of Tropical Agriculture (IITA) Ibadan, Nigeria. The samples were stored at 4°C until when needed. Two hundred grams (200g) of soybean were sorted to remove any foreign matter and then roasted in five batches of 40g each for 40min in a shallow pan under low heat at 200°C. The roasted beans were then dehulled manually, cooked for 1h, with twice its volume of tap water and the water drained off. The hot beans were spread on a Calabash lined with papaya leaves and then covered with more of the leaves. This was subsequently left to ferment for 48h at room temperature (25°C). Two hundred grams (200g) seeds of locustbean were cooked in water for 6h with occasional addition of more water as the original water evaporated. The beans were then dehulled, cooked for 30mins and the water drained off thereafter. The hot beans were spread in a calabash lined with papaya leaves, covered with more of the leaves and then left to ferment for 48h at room temperature (25°C). Samples were fermented in duplicate, while the functional properties were assayed in the raw and dawadawa samples of the legumes in triplicate.

### Analysis

#### Gelation Capacity

A modified method of Coffman and Garcia (1977) was used for the determination of gelation capacity. Sample suspension of 20-30% (W/V) were prepared in 5 mls distilled water. The test tubes containing these suspensions were then

heated for 1h in a boiling water bath, followed by rapid cooling under running tap water. The test tube were further cooled for 2h at 4°C. The yeast gelation concentration was determined as that concentration when the sample from the invested test tube did not fall or sleep.

The emulsion stability was determined using the sample prepared for emulsion capacity measurement. It was heated for 15min at 85°C according to the method of Naczki et al (1985), cooled and divided evenly into two 50ml centrifuge tubes. It was then centrifuged at 1100xg for 5min. The emulsion stability was expressed as percentage of emulsifying activity remaining after heating.

## RESULTS AND DISCUSSION

### Water and oil absorption capacity

Table 1 shows the results of the water and oil absorption capacity. Water absorption capacity values of raw locustbean and soybean were 213.0% and 116.50% respectively. Correspondingly, fermented sample had values of 145.0% each. Fermentation decreased the WAC of locustbean. Fermentation decreased water absorption capacity of sorghum meal and this may be due to degradation of starch (Chandrasekhar and Desikachar, 1983), known to increase water absorption capacity (Kilara et al, 1972). In contrast, WAC of fermented soybean increased significantly ( $P < 0.05$ ). This result suggested that fermentation of soybean affected the native proteins. Proteins consist of subunit structure and dissociate on heating as observed by Catsimpoola and Meyer (1970). Thus heating being one of the processing steps employed in addition to the hydrolytic effect of fermentation would have dissociated the protein into subunits. Dev and Quensil (1988) reported that the subunits have more water binding sites (increase in the number of hydrophilic groups which are the dissociation of protein resulting in an unmasking of non-polar residues from within the protein molecule; Narayana and Narasinga Rao, 1982; Abbey and Ibeh, 1987).

Oil absorption capacity (OAC) of raw locustbean and soybean were 78.35% and 80.0%, while corresponding values for the fermented products were 66.67% and 73.33% respectively. This reduction could be attributed to the configurational changes in the constituents of the sample during fermentation. Oil retention has been attributed to the physical entrapment of the lipid by the protein (Quin and Bechat, 1975 and Padmashree et al, 1987). The reduction in oil retention capacity of the fermentation product indicates that hydrophilic and lipophilic protein groups were not significantly affected by the 48h of fermentation. Similar trend was also reported by Bulgarelli and Beuchat (1990). The increase in WAC of the samples suggested that dawadawa could be utilized as a soup thickener. Oil is a desirable attribute in Nigerian soup and as such OAC for a seasoning is not a prerequisite or not a desirable attribute.

### Emulsion Capacity (EC)/ Stability (ES)

Table 2 shows the emulsion capacity (EC)/ emulsion stability (ES) of locustbean and soybean. Fermentation caused a considerable reduction in the emulsion capacity of soybean sample. The raw and fermented samples had EC values of 52.67% and 6.40% respectively. Both fermented soybean showed good stability of the emulsion formed. Even though, fermented locustbean had greater EC than the raw bean (36.65% and 13.30% respectively), the stability was greatly reduced on heating, with values of 8.68% and 3.78% correspondingly. Several researchers have investigated the emulsifying properties of various enzymatically hydrolyzed proteins (Kuehler and Stine, 1974; Adler-Nissen and Olsen, 1979; Lee et al, 1987; Chobert et al, 1988a,b; Turgeon et al, 1991, 1992; Gauthier et al, 1993). The reduction in the capacity of soybean dawadawa to form emulsion is not unusual. Earlier workers, McWatters and Cherry (1977) and Narayana and Rao (1982) reported that heat processing had a reductive effect on the emulsification capacity of legumes. Therefore, the decrease could be as a result of heating which was employed prior to fermentation of the

TABLE 1 Water and Oil Absorption Capacity of Raw and Fermented Locustbean and Soybean

Sample	Water Absorption	Oil Absorption
Raw locustbean	213.00 <sup>a</sup>	78.35 <sup>b</sup>
Fermented locustbean	145.00 <sup>c</sup>	66.67 <sup>c</sup>
Raw Soybean	116.50 <sup>d</sup>	80.00 <sup>b</sup>
Fermented Soybean	145.00 <sup>c</sup>	73.33 <sup>d</sup>

\* Columns with the same superscript are not significantly different ( $P < 0.05$ ) Values are means of triplicate determinations.

**Table 2: Emulsion Capacity /Stability of Raw and Fermented Locustbean and Soybean**

Sample	Emulsion Capacity	Emulsion Stability
Raw locustbean	13.30 <sup>a</sup>	3.78 <sup>f</sup>
Fermented locustbean	36.65 <sup>e</sup>	8.68 <sup>d</sup>
Raw soybean	52.67 <sup>a</sup>	50.25 <sup>a</sup>
Fermented soybean	6.40 <sup>f</sup>	6.17 <sup>e</sup>

Columns with the same superscript are not significantly different ( $P < 0.05$ ).

Values are means of triplicate determinations.

**Table 3: Gelation Capacity of Raw and Fermented Locustbean and Soybean Concentration % (W/V)**

Sample	20	22	24	26	28	30
Raw soybean	-	-	-	+	++	X
Fermented soybean	-	-	-	-	-	+
Raw locustbean	-	-	-	+	+	++
Fermented locustbean	-	-	+	+	++	X

X = least conc. end point, lowest sample conc. at which gel remained in the inverted tube;

- = No gelation; X = gelation; + = viscous; ++ = very viscous;

\* column with same superscript are not significant at  $P < 0.05$ .

\* Values are means of three determinations.

soybean. Padmashree et al. (1987) also reported a similar finding.

However, Adler-Nissen and Olsen (1979) noted a significant increase in the emulsifying capacity of soybean protein isolate, hydrolyzed by carefully controlling the extent of hydrolysis through a fungal protease, but as hydrolysis continued, the emulsifying capacity decreased substantially. Similarly Chobert et al (1988b, 1989) and Haque and Mozaffar (1992) reported an increase in emulsifying activity of hydrolysates of whey protein and casein by limiting the extent of hydrolysis, but emulsion stability of the resultant hydrolysate decreased considerably. The observed improvement in the emulsifying properties upon very limited hydrolysis could be presumably due to a hydrophobic protein interior (Phillip and Bechat, 1981), which enhances adsorption at the interface, forming a cohesive interfacial film (Phillipi, 1981), with the hydrophobic residues interacting with oil and hydrophilic residues with water (Turgeon et al, 1992). Extensive hydrolysis, however, resulted in drastic loss of the protein emulsifying properties (Mahmoud et al, 1992). Generally, the molecular weight of the hydrolysates has a major influence on their emulsifying properties. Several reports have suggested that there is an optimum molecular size or chain length for peptides to provide good emulsifying properties (Kuehler and Stine, 1974; Adler-Nissen and Olsen, 1979; Lee et al, 1987). The chain lengths of the proteins formed during fermentation might have determined the emulsification capacity of the legumes. Nigerian soups are basically oil-in-water emulsions with dispersed ingredients, thus the good stability of the emulsion formed with soydawadawa suggested, that soups prepared with soydawadawa will be better preserved as the emulsion formed will be stabilized.

### Gelation Capacity (GC)

The result of gelation capacity of the legumes is shown in Table 3. Raw soybean had least gelation concentration (LGC) at 30%, while fermented soybean was only viscous at 30%. This result is consistent with a report by Adler-Nissen and Olsen (1979), who observed no gel formation by soy protein hydrolyzed by an enzyme. Mahmoud (1994) reported that one of the unique properties of protein hydrolysates that has practical significance in nutrition is their lack of thermally induced gelation. The reduced hydrophobicity of protein hydrolysates caused by hydrolysis (Mahmoud et al, 1992) may explain the inability of the hydrolysates to form heat-induced gels, hence hydrophobicity of proteins has been positively correlated with formation of thermally

induced gels (Kohnhorst and Mangino, 1985; Mangino et al, 1987). Additionally, increased net charge on the protein hydrolysates as a result of hydrolysis (Mahmoud et al, 1992) could also result in presumably increased charge repulsion between the peptides, leading to their loss of gelation ability. A critical balance of attractive and repulsive forces must be attained for proteins to form gels (Paulson and Tung, 1989). Raw locustbean formed a coagulation at 30% (W/W), which could not prevent slippage of the gel, while the fermented locustbean had LGC at 30% (W/W). The LGC reported for other legumes such as the great northern bean (*Phaseolus vulagris L.*) was 10% (Sathe and Salunkhe, 1981); winged bean flour was 10% (Sathe et al, 1982). Sathe et al, (1982) associated the variation in the gelation property of different legume flours to the relative ratios of different constituents: protein, carbohydrates and lipids, that make up the legume; suggesting that interaction between such components might have a significant role in functional property. The gelling ability of locustbean dawadawa is of significance because this property is desired in some Nigerian soups. However, there are other Nigerian soups in which gelling ability of an ingredient is not desired, and in this case, soydawadawa could be utilized.

### CONCLUSION

Bacterial fermentation of locustbean and soybean generally improved the functionality of the product, dawadawa, it could be utilized in food systems, where some modifications in physiochemical parameters is required as in some Nigerian soups.

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