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Solubility and Functional Properties of Boiled and Fried Locust (*Anacridium melanorhodon*) as Influenced by pH Levels

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Abstract: The protein solubility and functional properties of boiled and fried locust were determined at different pH in order to ascertain their suitability as food or food ingredients. The results indicated that the emulsifying activity, emulsion capacity and foaming capacity were affected by pH. For both boiled and fried locust, high values for the parameters were obtained at alkaline region and low values at acidic range except foaming capacity. However, the emulsion stability for both treated locust was of no regular pattern of change at both acidic and alkaline region. However, for both boiled and fried locust the emulsion and foam stability were higher at alkaline region than at the acidic one. The results obtained showed that the protein of the treated locust was slightly soluble and the insolubility of the protein reflects on the other functional properties.

Key words: Tree locust, boiled, fried, functional properties, pH, solubility

INTRODUCTION

Insects have played an important role in the history of human nutrition. In Africa, Asia and Latin America (Duffey, 1980). Aletor noted that *Anaphae venata* is a good source of protein in human diet since it averagely contains about 22.1g 100 g^{-1} of protein and Ashiru (1988) reported a calorific value of 611 k cal (2266 kj) 100 g^{-1} for the caterpillar of *Anaphae venata.* Other beneficial insects live on organic remains, helping to recycle nutrients that plants can then use. These recycles include minute insects, such as springtails and a variety of heavily built beetles. Some of these beetles bury the carcasses of small bird and mammals; slowly away the ground until the corpse sinks below the surface. In Sudan, insects are not only widely in Western Sudan villages market but many make their way to urban markets and restaurants. Some of the selected dominant insect species are pests of some of economic timber tree species such as *Anaphe venata*, which browses on the leaf of *Triplochiton scleroxylon.* A 10% increase in the world supply of animal proteins through mass production of insects can largely eliminate the malnutrition problem and also decrease the pressure on other protein sources (Robert, 1989). Functionality has been defined as any property of a food ingredient, except its nutritional value, that has a great impact on its utilization (Mahajan and Dua, 2002). Functional properties constitute the major criteria for the adoption and acceptability of proteins in food systems. Protein functional properties are determined to a large extent by a protein's physicochemical and structural properties (Damodaran, 1990). Protein solubility is an important prerequisite for food functional properties and it is a good index of potential applications of proteins (Kinsella, 1976). Hydration properties, dispersibility, water absorption, binding, swelling and viscosity are known to directly influence the characteristics of a food system (McWatters, 1983). Hydration of proteins is vital for several functional properties, such as emulsion capacity, foaming, viscosity and gelation. The solubility of protein depends on hydration and the degree of hydrophobicity of the protein molecules (Sathe and Salunkhe, 1981). The objective of this study was to investigate the protein solubility and functional properties of boiled and fried locust flour as a function of pH.

MATERIALS AND METHODS

Two samples of boiled and fried tree locusts (*Anacridium melanorhodon melanorhodon*) were obtained from Mayo local market-Khartoum. Refined Ground nut oil was brought from Bittar Co. Ltd.,

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Khartoum. Sudan. Unless otherwise stated all chemicals used in this study were of reagent grade. Locust was first cleaned, freed from foreign matter, separated inedible part and milled in a laboratory miller to pass through 0.4 mm screen. To extract oil from milled flour, cold extraction method was used.

Determination of nitrogen solubility at different pH: Nitrogen solubility of both boiled and fried locust flour was determined at different pH values (2, 4, 6, 8, 10) using the procedure of Quinn and Beuchat. About 0.2 g of the samples were suspended in 10 ml distilled water and shaken for 15 min before the desired pH was maintained by addition of 1.0 N HCl or 1.0 N NaOH. The suspension was shaken for 45 min and centrifuged at 3000 rpm for 20 min at room temperature (30°C). The soluble nitrogen in the supernatant was determined following the AOAC method. Nitrogen solubility was expressed as percent of the total nitrogen content of the sample.

Emulsion measurement at different pH: The Emulsification Capacity (EC) of the sample was estimated by the method of Beuchat *et al.* (1975). EC was expressed as milliliters of oil emulsified by 1.0 g material. The Emulsification Activity (EA) was measured by the procedure of Yatsumatsu *et al.* (1972). Emulsion Stability (ES) was measured by recentrifugation followed by heating at 80°C for 30 min. ES was expressed as the percent of the total volume remaining emulsified after heating.

Foam measurement at different pH: Foaming Capacity (FC) of the sample was determined by following the procedure described by Lawhon *et al.* (1972). The Foam Stability (FS) was conducted according to Ahmed and Schmidt (1979). The FS was recorded at 15 min interval for 2.30 h after pouring the material in a cylinder.

Statistical analysis: Each determination was carried out on 3 separate samples and analyzed in triplicate. The data were subjected to analysis of variance and the Duncan's multiple range test was used to separate means.

RESULTS AND DISCUSSION

Effect of pH on protein solubility of boiled and fried locust flour: The protein solubility of boiled and fried tree locust at various pH values is shown in Fig. 1. Boiled locust had a lowest protein solubility of 4.8% at pH 8 and the highest one was observed at pH 10, while, fried locust had a minimum solubility percent at pH 2 and 4 and then it progressively increased specially at alkaline region.

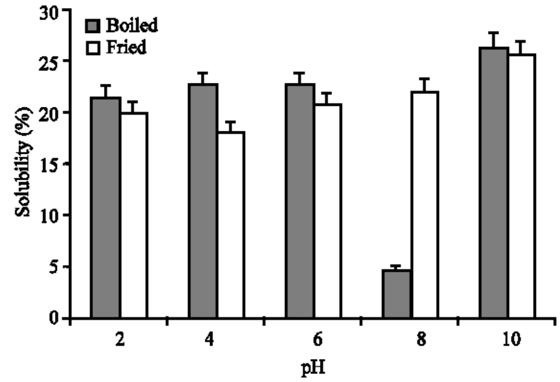


Fig. 1: Effect of pH on protein solubility (%) of fried and boiled locust

Results obtained for fried locust agreed with that reported by Fagbemi *et al.* (2006) who stated that, a minimum protein solubility was observed at pH 4 and the maximum protein solubility was observed at pH 9. Generally, the dependency of protein solubility on pH has been attributed to the change in the net charges carried by protein as the pH changes (Fagbemi *et al.*, 2006). It was observed that when the locust was boiled the isoelectric pH was shifted from 4 to 8 due to change in protein nature as a result of heating. Higher solubility values were obtained at alkaline region. The higher solubility of locust protein at alkaline region indicated that it might be a useful protein in the formulation of alkaline foods like meat products.

Effect of pH on the emulsifying properties of boiled and fried locust flour: Figure 2 shows the results of the emulsifying activity of boiled and fried tree locust at different pH values. The results showed that boiled locust, had a lower value at pH 6 (46.30%) and then gradually increased on either side of pH. This result agreed with that reported by Massoura *et al.* (1996) who found that the lower emulsifying activity occurred at pH 6 due to low protein solubility at this pH. For fried locust the lowest emulsifying activity obtained at pH 2 (25.33%) and the maximum obtained at pH 8 (40.1%). The results obtained agreed with that of Yim and Lee (2000), Khalid *et al.* (2003), Monteiro and Prakash (1994) who observed higher emulsifying activity of soybean, sesame and peanut proteins, respectively at alkaline pH than at acidic one. Variation in the results between boiled and fried locust might be due to processing effect which may cause protein interaction that affected the surface hydrophobicity and the net charged of the protein (Khalid *et al.*, 2003). Figure 3 illustrates the emulsification capacity of both samples at d ifferent pH levels. It was

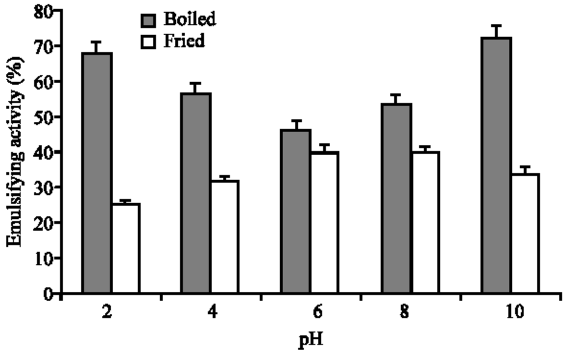


Fig. 2: Effect of pH on emulsifying activity (%) of fried and boiled locust

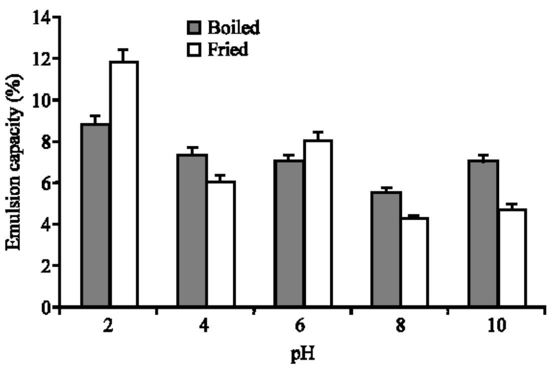


Fig. 3: Effect of pH on emulsion capacity (%) of fried and boiled locust

observed that the emulsion capacity of both boiled and fried locust was affected by pH, where it was higher at acidic region (pH 2) and lower at alkaline (pH 8). These results were disagreed with that obtained by Idris *et al.* (2003) who found that the lower value of the emulsifying capacity was observed at acidic region (pH 5). This variation possibly might be due to variation in chemical nature of tested samples. Figure 4 shows the results of emulsion stability of boiled and fried tree locust at different pH values. The results showed that the change of emulsion stability as affected by pH values was of no consistent pattern for the boiled locust. The lowest value of the emulsion stability was observed at pH 8 (55.53%) and the maximum was observed at pH 6 (89.43%). The results obtained agreed with that reported by Khalid *et al.* (2003) who found that the emulsion stability was higher at pH 6 (93.09%) and it decreased at alkaline pH. For fried locust the emulsion stability recorded low value at pH 6 (25.66%), but showed a remarkable increase on either of this pH. Similar trend was obtained by Khalid *et al.* (2003) who found that the emulsion stability of sesame protein isolate was higher at acidic region (75.0%) than at alkaline region (62.0%) with a minimum emulsion stability at pH 4.9 (37.8%).

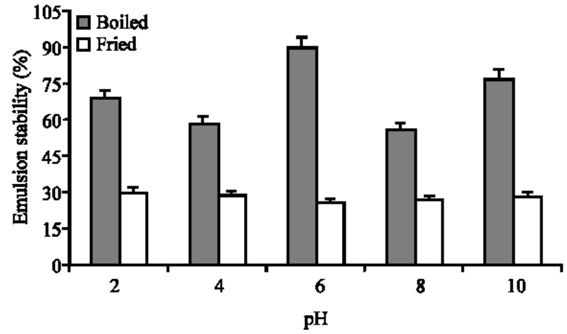


Fig. 4: Effect of pH on emulsion stability (%) of fried and boiled locust

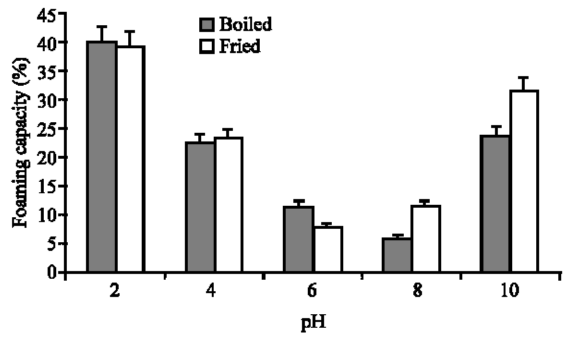
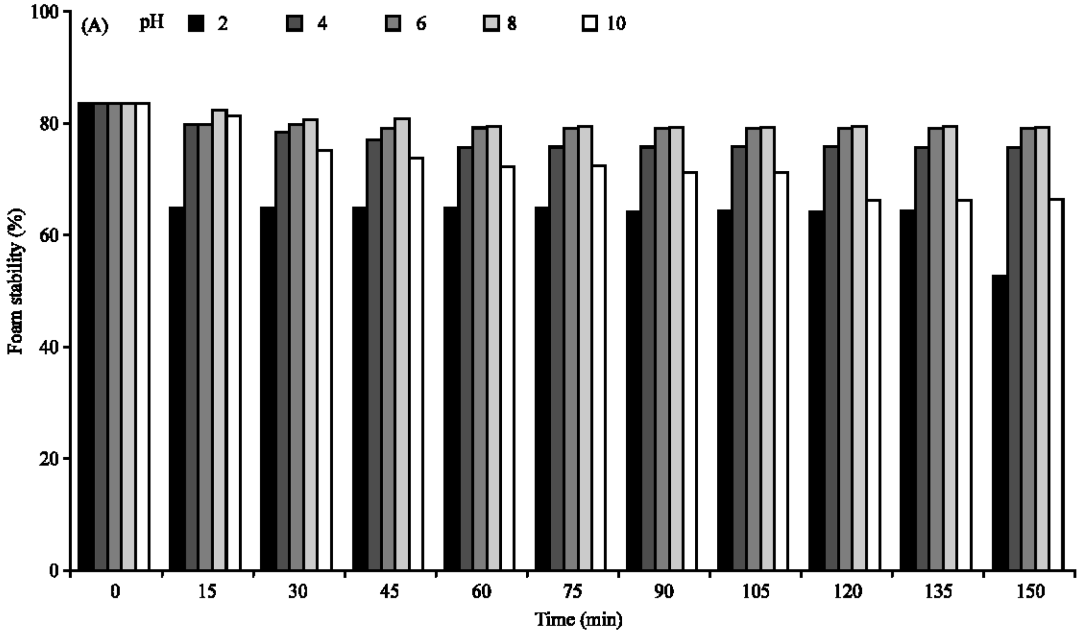


Fig. 5: Effect of pH on foaming capacity (%) of fried and boiled locust

Effect of pH on foaming properties of boiled and fried tree locust flour: Figure 5 shows the results of foaming capacity of boiled and fried tree locust at different pH values. The results showed that, for boiled locust the lower value was observed at pH 8 (5.80%) and the maximum value was observed at pH 2 (40.0%). For the fried locust, the lowest foaming capacity value was observed at pH 6 (7.80%) and the maximum value was observed at pH 2 (39.20%). The results obtained disagree with that reported by Odoemelam (2005) who stated that the capacity to produce foam was pH dependent with a maximum value at pH 4.0. The effect of pH values on foam stability of boiled and fried tree locust flour is shown in Fig. 6a and b. The results showed that for the boiled locust at both acidic and alkaline pH foam stability was significantly differed at a given time (Fig. 6a). When the foam stands for 45 min, the foam stability increased with increase in pH value till pH 8 and thereafter started to decrease. For the fried locust (Fig. 6b) at pH 2 no



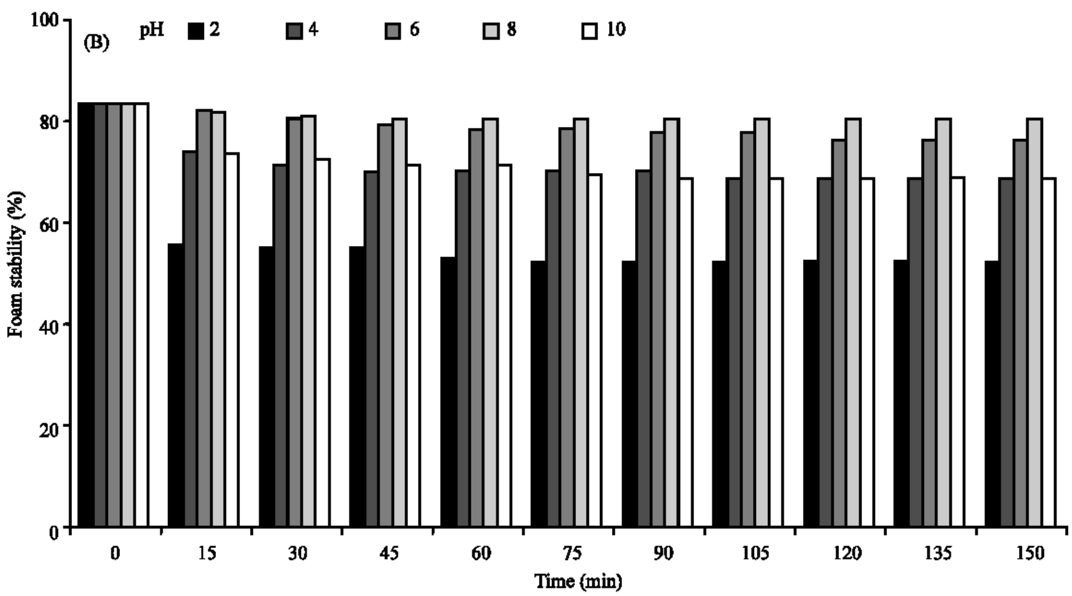


Fig. 6: Effect of pH on foam stability (%) of (A) boiled and (B) fried locust

significant difference was observed with time up to 90 min while at pH 4, 6 and 8 no significant difference beyond 45 min. Moreover, for both boiled and fried locust at a given time a significant change was observed but not consistent at both acidic and alkaline pH. On the other hand, the results indicated that the foam stability of boiled locust at different pH values and for different times was significantly different. The present finding was supported by the results obtained by Idris *et al.* (2003) who stated that the foam stability was greatly affected by the pH of the medium.

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