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Chemical composition, physicochemical and functional properties of akee (*Bilphia sapida)* pulp and seed flours

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Abstract

Proximate and mineral compositions, together with functional properties, of *Bilphia sapida* pulp and seed were studied. Also, physicochemical characteristics of the seed's oil were determined. The pulp contained higher percentages of crude fat, crude protein, total ash and moisture than the seed. The most abundant mineral was potassium, in both. The reddish-coloured oil obtained from *B. sapida* had an acid value of 14.2 mgKOH/g, specific gravity of 0.9510, refractive index of 1.462, and saponification value of 177.Protein solubility studies showed that both seed and pulp protein were soluble at acidic and basic pH regions, indicating that they may be useful in formulating acid foods, such as meat and milk analogue products and protein-rich beverages. The protein solubility curves showed that two different isolates might be recovered from pulp at pH 4.0 and 10.0 and from the seed at pH 3.0 and 7.0.Their relatively high emulsion and oil absorption capacities suggest their use in the production of sausages, soups and cakes with improved flavour-retaining capacities and mouth-feel. The foaming capacity is low but relatively stable.

Keywords: Chemical; Physicochemical; Functional properties; Akee

1. Introduction

Akee apple (*Bilphia sapida)*, commonly known as "Isin" among the Yoruba tribes of Nigeria, is a wild food plant that belongs to the family of *Sapidaceae*. The flower is small, greenish-white and about 5 mm long (Purseglove, 1987). The fruit, when ripe, splits to expose a fleshy cream-coloured pulp attached to a shiny black oblong seed.

Owonubi (1986) reported that the fleshy pulp is usually eaten raw, made into soup or fried in oil. The fruit is also a medicinal plant.

While some works have been reported on the vitamin C, sugar contents (Akande, 1989) and edibility of the pulp (Rice, Rice, & Tindall, 1987), there is little information on the compositional analysis of the fruit's pulp and seed or physicochemical properties of the seed oil. This work seeks to study these as well as to determine the functional properties of the *B. sapida* seed, and pulp flour as part of our continuing research into new vegetable protein sources, to know whether the fruit could be used for food applications.

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2. Materials and methods

2.1. Collection and preparation of sample

Fresh *B. sapida* fruits were collected from Ado-Ekiti, Ekiti State, Nigeria. The pulps were nipped from the black shiny seeds. The hard testa of the seeds were removed with a knife. The pulp and seeds were kept separately in plastic containers in a refrigerator at 4 °C. Prior to analysis, the pulp and seeds were dried in the oven at 50±5 °C for 48 h. They were then separately ground to fine powder.

2.2. Proximate analysis

The proximate analyses of the samples for moisture (AOAC, 1990) crude fat and total ash were carried out in triplicate. Nitrogen was determined by the micro-Kjeldahl method described by Pearson (1976) and the percentage nitrogen was converted to crude protein by multiplying by 6.25. The total carbohydrate content was determined by difference (James, 1996; Oshodi, 1992) in triplicate.

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2.3. Mineral analysis

The minerals were analysed from solutions obtained by first dry-ashing the seed flour at 550 °C. The ash obtained was boiled with 15 cm^3 of 20% hydrochloric acid in a beaker, filtered into a 100 cm^3 standard flask and made up to the mark with distilled water. Sodium, potassium, magnesium, calcium, iron, copper and zinc were determined using an atomic absorption spectrophotometer (Pye Unicam Sp 9, Cambridge), while phosphorus was determined colorimetrically by a Spectronic 20 (Gallenkamp, London), using the phospho-vanado-molybdate method (AOAC, 1990). All determinations were in triplicate.

2.4. Functional properties

The protein solubility profiles of the seed proteins was determined by dissolving lg of the flour in 10cm^3 IM NaOH ,followed by adjustment to the desire pH using IM HCI. The solution was then centrifuged for 15 min at 5000 rpm before the protein content of the supernatant was determined by the micro-Kjeldahl method (Pearson, 1976). The least gelation concentration, water and oil absorption capacities, foaming capacity and stability of the seed and pulp flour were determined, using the method of Sathe, Deshpande, and Salunkhe, (1982). The emulsion capacity was determined according to the method of Ige, Ogunsua, and Oke (1984).

2.5. Physicochemical properties of B. sapida oils

B. sapida seed and pulp oil were obtained by the soxhlet extraction method (James, 1996). The Physicochemical analysis of the oil, for acid value, iodine value, saponification value, peroxide value, free fatty acid, refractive index and specific gravity, were carried out according to methods of AOAC (1990).

3. Results and discussion

3.1. Proximate and minerals composition

Table 1 presents the proximate composition of *B. sapida* pulp and seeds. The pulp had higher percentages of crude fat, crude protein, total ash and moisture than the seed. The percentage carbohydrate (by difference) of the seed is, however, much higher than that of the pulp. The higher moisture content of the pulp than the seed would imply higher susceptibility of the pulp to microorganism attack than the seed. The moisture content of the *B. sapida* seeds is comparable to that of *Citrullus vulgaris* (8.23%), reported by Ige et al. (1984).

The fat content of the pulp (45.50%) is comparable to that reported for *C. vulgaris* (47.9–51.1%) by Ige et al. (1984), and for pumpkin seed (49.2 and 47.0%) (Aisegbu, 1987; Fagbemi & Oshodi, 1991). *B. sapida* pulp is a better source of oil than soybean seed which has only 23.5% fat (Paul & Southgate, 1980).

It has been established by Pomeranz and Clifton (1981) that ash contents of nuts, seeds and tubers should fall in the range 1.5–2.5% in order to be suitable for animal feed. The ash content of *B. sapida* seed falls in this range; hence its use as an animal feed can be proposed. This use is also favoured by the high carbohydrate content (42.5%) of the *B. sapida* seed.

The crude protein contents, 24.3 and 21.5% for *B. sapida* pulp and seed respectively, are highly comparable to protein-rich foods, such as cowpea and pigeon pea (Olaofe, Mustapha, & Ibiyemi, 1993), chick beans 19.4% and lima bean 19.8% (FAO, 1982).

Table 2 presents the mineral composition of *B. sapida* pulp and seeds. The least abundant minerals in the pulp and seed were Zn and Cu respectively, while the most abundant mineral was K in both. The table also reveals that Mg, Ca, Fe, K and Cu are evenly distributed between the pulp and the seeds. The values obtained for Mg, Fe, and P are reasonably high in both pulp and seeds and may satisfy the nutritional needs of the consumers.

3.2. Physico-chemical properties

Table 3 presents the physico-chemical characteristics of *B. sapida* oils. The reddish-coloured oil has an acid value of 14.2 mg KOH/g. In view of the fact that acid

Table 1
Proximate composition of *Bilphia sapida* pulp and seed (%)

Components	Pulp	Seed
Moisture	13.80	8.05
Crude fat	45.50	11.75
Crude protein	24.3	21.5
Crude fibre	4.23	13.8
Total ash	5.60	2.41
Carbohydrate (by difference)	6.53	42.5

Table 2
Mineral content of *Bilphia sapida* seed and pulp (mg/100 g of sample)

Mineral	Pulp	Seed
Na	124	136
K	951	941
Mg	271	341
Ca	32.6	31.1
Fe	17.5	20.9
Cu	8.1	8.2
Zn	6.5	14.5
P	240	78.1

values of edible oil should not exceed 4.00 mg KOH/g (Akintayo, 1997), the *B. sapida* oil could only be recommended for industrial use. The oil has a specific gravity of 0.9510, indicating that its less dense than water. Its refractive index of 1.462 shows that the oil is thicker than most drying oils, such as linseed oil, soybean oil and cod liver oil (with refractive indies between 1.475 and 1.485) (Duel, 1951). The iodine value of *B. sapida* oil is 65.4, indicating nondrying, since drying oils have an iodine value above 100 (Duel, 1951).

3.3. Functional properties

The results for variation of protein solubility with pH are presented in Fig. 1. The pH dispersion curves for the pulp and seeds are similar to the patterns described for soybean (Smith & Circle, 1938), Great Northern bean (Sathe et al., 1982) and *Telfairia occidentalis* (Akintayo, 1997). Fig. 1 indicates that the seed and pulp proteins have a minimum solubility at pH 3.0 and 4.0, respectively. The inflections in the solubility profiles of both the pulp and seed indicate that two different isolates might be possible, i.e pH 4.0 and 10.0, for the pulp extraction, while, for the seeds, one would be extractable at pH 3.0 and another at pH 7.0. The solubilities of the *B. sapida* seed proteins are higher than those of the pulp protein. It might be of economic significance that, at the point of minimum solubility, more of the *B. sapida* seeds are in solution compared than for the pulp. The figure, further indicates that the proteins of both pulp and seed flours are soluble at both acidic and basic pH. This observation is similar to that of *Adenopus breviflorus* benth and soybean flour concentrate (Oshodi, 1992; Padilla, Alvarez, & Alfaro, 1996).These results suggest that there is more extraction of soluble proteins at alkaline pH, as been reported by Ma and Harwalkar (1984) or there is a denaturation which increases protein solubility (Padilla et al.). The solubilities of *B. sapida* seed and pulp flour proteins in both acid and alkali indicates that they may be used in the formulation of acid foods, such as meat and milk-analogue products and protein-rich beverages (Kinsella, 1979; Olaofe, Arogundade, Adeyeye, & Falusi, 1998; Olaofe et al., 1993; Oshodi & Ekperigin, 1989; Pomeranz, 1991)

The results obtained for other functional properties are presented in Table 4. The water absorption capacity (WAC) of *B. sapida* seed, 135%, is greater than WAC of *B. sapida* pulp, 80%. The WAC of the seed is comparable to that of soyflour (130%) but higher than that of

Table 3
Physico-chemical characteristics of *Bilphia sapida* oils

Properties	Value
Specific gravity	0.9510
Refractive index	1.462
Acid value	14.2
Saponification value	177
Iodine value	65.4
Peroxide value	386
Free fatty acid	8.00

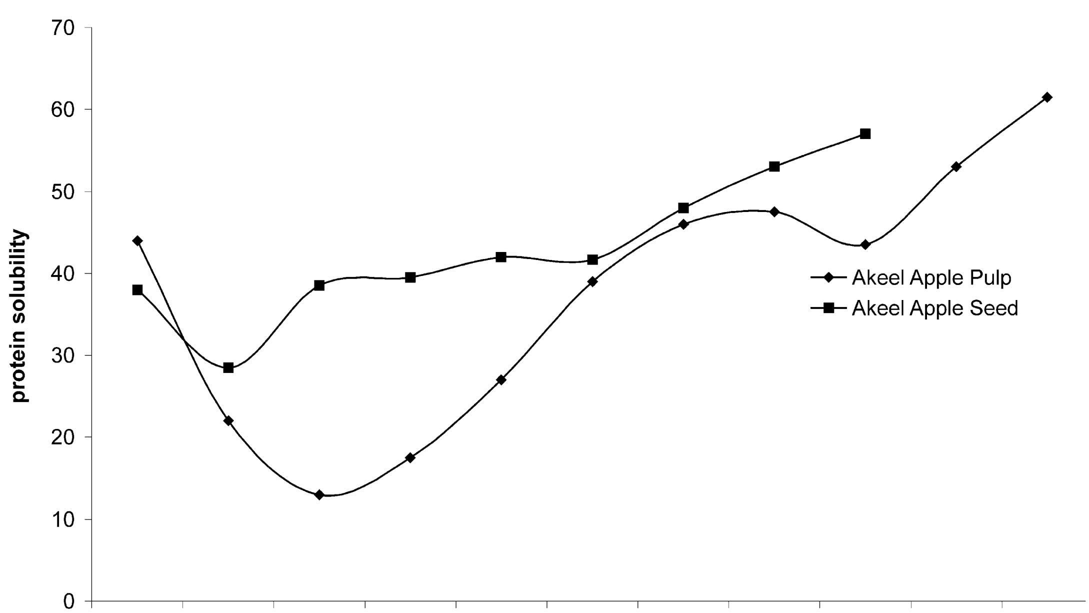

Fig. 1. Variation of protein solubility of *Bilphia sapida* with pH.

Table 4
Functional properties of *Bilphia sapida* pulp and seeds (%)

Functional properties	Pulp	Seed
Water absorption capacity	80	135
Oil absorption capacity	131.6	125.0
Least gelation concentration	8.0	4.0
Emulsion capacity	25.98	25.65
Foaming capacity	26.62	27.05
Foaming stability (after 2 h)	11.38	8.20

sunflower (107.1%) (Lin, Humbert, & Sosulski, 1974) and *Telfairia occidentalis* (90.2%) (Akintayo, 1997).

The oil absorption capacity of the *B. sapida* pulp and seed are 131.6 and 125.%, respectively . These values are high compared to that of soybean (84.4%) and wheat (84.2%) flours, but lower than the 207.8% reported for sunflower (Lin et.al., 1974). The least gelation concentration (LGC) of the *B. sapida* pulp is 8% while that of the seed is 4.0%. These values imply that both the pulp and seed may be better gelating and agents than lupin seed flour and winged bean with LGC vaules of 14 and 18%, respectively (Sathe et al. 1982) and pigeon pea, 12%, (Oshodi & Ekperigin, 1989), *Adenopus breviflorus* benth seed, 16% (Oshodi, 1992) and fluted pumpkin seeds, 14% (Akintayo, 1997). Variation in gelling properties of different legume flours may be linked to the relative ratios of different constituent, proteins, carbohydrates and lipids and interactions between such components may affect functional properties (Sathe et al., 1982).

The emulsion capacities of 25.98 and 25.65% for the pulp and seed, respectively, are greater than the 18% reported for soyflour and double the value of 11.7% reported for wheat, but lower than the value 95.10% recorded for sunflower flour by Lin et al. (1974).

The foaming capacity and stability of the *B. sapida* pulp and seed are also presented in Table 4. The foaming capacities of 26.62 and 27.05% for pulp and seeds, respectively, are a little higher than that of *A. breviflorus* benth seeds, 21.50% (Oshodi, 1992) but much lower than that of soyflour (70%), or sunflower flour (230%) reported by Lin et al., (1974). The foaming stability after 2 h for the *B. sapida* pulp (11.38%), is better than that of the seed (8.20%). Both are, however, comparatively better than that of soy-protein concentrate, 5%, as reported by Lin et al. (1974) for the same time interval.

4. Conclusion

B. sapida pulp and seed are rich in important food properties compared to some other oil seeds and nuts. In view of the assessed functional performances, the use of *B. sapida* in model food systems may be suggested.

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