Food Chemistry 53 (1995) 173–175

0308-8146/95/$9.50

ELSEVIER

# Effect of heat-treatment and defatting on the proximate composition of some Nigerian local soup thickeners

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(Received 12 January 1994; revised version received and accepted 3 May 1994)

A comparative study of the effect of heat-treatment and defatting on the proximate composition of melon seeds (*Colocynthis citrullus* Linn.), dikanut seeds (*Irvingia gabonensis*) and cocoyam tuber (*Colocasia esculenta*), mostly used now as conventional soup thickeners in southern Nigeria, was carried out. There was generally no significant difference in proximate composition between raw and heat-processed samples at the 5% level ($P = 0{\cdot}05$). In raw and defatted samples, the level of protein in melon seeds was 59·4% higher than in dikanut seeds and 90·3% higher than in cocoyam tuber; but in heat-processed and defatted samples, the protein level in melon seeds was 56·9% higher than in dikanut seeds and 87·5% higher than in cocoyam tuber. Similar trends were observed in the ash contents and ether extracts for both raw and heat-processed samples.

However, the level of carbohydrate in raw defatted cocoyam tuber was 29·7% higher than in dikanut seeds and 75·1% higher than in melon seeds, but in heat-processed and defatted samples, carbohydrate level in cocoyam tuber was 36·9% higher than in dikanut seeds and 76·3% higher than in melon seeds. In the undefatted raw and heat-processed samples, the calorific values determined using Atwater factors were highest in dikanut seeds and lowest in cocoyam tubers.

## INTRODUCTION

The problem of protein–calorie malnutrition in Nigeria has now transcended socio-economic status in its effects. Until quite recently in Nigeria, especially in the southern parts, little or no attention has been given to the use of melon, dikanut and cocoyam, due to an abundance of protein and energy-giving foods. However, the present harsh economic situation in the country, and the consequent negative effects of the structural adjustment programme, have resulted in attention being given to the cultivation of melon, dikanut and cocoyam. These are now used, not only as soup thickeners, but as essential components of soup ingredients that enhance the protein and carbohydrate levels in foods.

Melon belongs to the Cucurbitaceae family but is often confused with other family members (Oyolu, 1977). The seed is particularly rich in proteins and oil (Oyenuga, 1968; Oyolu, 1977). The seed kernel has traditionally become useful as a basis for a number of soups in which egusi (melon) acts as a thickening, emulsifying, fat-binding and flavouring agent.

Dikanut belongs to the Simarubaceae family and is a species of *Irvingia*. It is commonly known as African mango (Eka, 1980). The fruit is yellow when ripe and resembles a small mango; the pulp surrounding the fibrous-coated hard-shelled nut is edible, though of a turpentine flavour, and in some cases is bitter and acrid. The single seed is more important in Nigeria and ranks as an oil seed (Abaelu & Akinrimisi, 1980). The seed is widely used in Nigeria as a popular soup thickener as it gelatinises into a thick, viscous sauce base for vegetable soup when mixed with water, oil and other condiments, and then heated.

Cocoyam belongs to the Araceae family and is grown in Nigeria mainly for its edible corm and leaves. The tuber or corm contains an acrid substance irritating to the digestive tract which can be associated with calcium oxalate which is usually dispelled when cooked. Lime juice relieves the acridity perceived after accidentally chewing raw tubers (Morton, 1968). Cocoyam is a good substitute for potato or yam as it can be ground into flour or made into fufu, and is presently widely used as a soup thickener in southern Nigeria.

Nutritional studies on these soup thickeners in Nigeria are scanty. There is therefore a need for a systematic investigation of the effects of heat-treatment and defatting on their proximate composition.

## MATERIALS AND METHODS

### Source of samples

All the samples were purchased from local markets in Port Harcourt. They were wrapped in black cellophane bags, put in sealed containers and stored in a refrigerator (4°C) for three days before they were processed.

### Sample preparation

The peeled and cleaned samples were ground separately using a domestic grinder. Some portions of the ground samples were defatted with petroleum ether (boiling point 40–60°C), while some were autoclaved at 121°C for 15 min and air-dried at 28 ± 1°C overnight (heat-processed).

### Analyses of samples

The recommended methods of the Association of Official Analytical Chemists (AOAC, 1984) were adopted for the determination of moisture, crude protein, ash and crude fat. Crude protein ($N \times 6{\cdot}25$) was determined by the Macro-Kjeldahl method using 1·0 g samples. Ash was determined by the incineration of 1·0 g of sample placed in a muffle furnace maintained at 550°C for 6 h until ash was obtained. Crude lipid (ether extract) was determined by exhaustively extracting 5·0 g of the sample with petroleum ether by use of a Soxhlet apparatus.

The level of carbohydrate was obtained by the difference method, that is, by subtracting the sum of the protein, fat, ash from the total dry matter. The calorific value was calculated by multiplying the mean values of the crude protein, fat and carbohydrate by Atwater factors of 4, 9 and 4, respectively, taking the sum of the products and expressing the result in kilocalories according to the method of Edem *et al.* (1990).

## RESULTS AND DISCUSSION

The results of proximate analysis of the undefatted raw and heat-processed samples used as local soup thickeners in Nigeria are presented in Table 1, while those of the defatted raw and heat-processed samples are listed in Table 2. There was generally no significant difference in proximate composition between raw and heat-processed samples at the 5% level ($P \leqq 0{\cdot}05$). It is evident from these results that defatting significantly increased moisture, ash, crude protein and carbohydrate content, and reduced the crude fat and calorific value in each of the samples studied. Undefatted samples may be stored for a longer time without spoilage than the defatted samples since the former contained relatively less moisture than the latter. This is expected since the presence of a higher moisture level would enhance microbial action.

In the undefatted sample, crude fat was highest in dikanut than melon but was lowest in cocoyam. The crude fat contents of 62·25 ± 0·55 and 53·23 ± 0·92 for raw dikanut and melon indicate that they are very good oil seeds. It has been reported that the crude fat content of African yam bean (2·50 ± 0·40 for raw and 2·30 ± 0·12 for cooked) does not qualify the beans as an oil-rich legume (Edem *et al.*, 1990), especially when compared with groundnuts and soyabeans which have been shown to have fat contents of about 40% and 19% respectively (FAO, 1968; Oyenuga, 1968). Carbohydrate content was highest in cocoyam followed by dikanut and then melon, while this trend was reversed in terms of crude protein. The high carbohydrate content in the defatted samples compared to the undefatted samples may be attributable to the low crude fat. Defatted melon flours have been shown to contain significant amounts of various vitamins, espcially thiamin and niacin as well as good quantities of sulphur, calcium, potassium, iron, magnesium, phosphorus and manganese (Akobundu *et al.*, 1982). The profiles of defatted melon flours show yields of essential amino acids that compare favourably with those of other oil seeds, especially sunflower meals (Sosulski & Sarwar, 1973) and, unlike most oil seeds, melon seed contains higher amounts of arginine, tryptophan, methionine and cysteine.

The low calorific value obtained in raw undefatted cocoyam compared to dikanut and melon was due to the low fat content and high carbohydrate content in the cocoyam. The reduction in calorific value due to defatting could be exploited in the formulation of a diet rich in protein but low in fat for patients suffering from

**Table 1. Proximate composition of undeffated raw and heat-processed samples used as soup thickeners**

| Constituent | Proximate composition (%)[a] | | | | | |
|---|---|---|---|---|---|---|
| | Melon | | Dikanut | | Cocoyam | |
| | Raw | Heat-processed | Raw | Heat-processed | Raw | Heat-processed |
| Moisture | 5·92 ± 0·07 | 4·43 ± 0·71 | 6·46 ± 0·06 | 4·68 ± 0·17 | 8·99 ± 0·01 | 11·81 ± 0·13 |
| Dry matter | 94·08 ± 0·09 | 95·57 ± 0·062 | 93·54 ± 0·04 | 95·32 ± 0·11 | 91·01 ± 0·03 | 88·19 ± 0·14 |
| Ash | 3·85 ± 0·07 | 3·75 ± 0·07 | 2·90 ± 0·14 | 2·45 ± 0·35 | 3·25 ± 0·35 | 4·15 ± 0·92 |
| Crude protein | 26·3 ± 2·47 | 28·0 ± 0·06 | 8·76 ± 0·01 | 7·89 ± 0·24 | 4·95 ± 0·44 | 6·73 ± 0·64 |
| Crude fat | 53·23 ± 0·92 | 53·03 ± 1·37 | 62·25 ± 0·55 | 65·93 ± 2·70 | 0·30 ± 0·00 | 0·35 ± 0·10 |
| Carbohydrate | 10·7 ± 3·53 | 10·8 ± 2·15 | 19·6 ± 0·75 | 19·1 ± 0·46 | 82·2 ± 0·80 | 77·0 ± 2·79 |
| Calorific value (kcal/100 g) | 521·83 ± 6·92 | 632·43 ± 3·52 | 673·81 ± 1·30 | 701·13 ± 8·40 | 352·54 ± 1·24 | 334·80 ± 4·53 |

[a]Values are means ± standard deviations of triplicate determinations.

**Table 2. Proximate composition of defatted raw and heat-processed samples used as soup thickeners**

| Constituent | Proximate composition (%)[a] | | | | | |
|---|---|---|---|---|---|---|
| | Melon | | Dikanut | | Cocoyam | |
| | Raw | Heat-processed | Raw | Heat-processed | Raw | Heat-processed |
| Moisture | 13·82 ± 0·04 | 13·18 ± 0·04 | 15·24 ± 0·20 | 19·80 ± 0·96 | 13·55 ± 0·04 | 12·19 ± 0·10 |
| Dry matter | 86·18 ± 0·04 | 86·82 ± 0·04 | 84·76 ± 0·20 | 80·20 ± 0·89 | 86·45 ± 0·03 | 87·81 ± 0·08 |
| Ash | 8·40 ± 0·00 | 8·00 ± 0·00 | 6·85 ± 0·40 | 6·55 ± 0·21 | 3·30 ± 0·28 | 3·55 ± 0·35 |
| Crude protein | 56·1 ± 2·47 | 57·0 ± 1·24 | 22·8 ± 0·00 | 24·5 ± 2·48 | 5·42 ± 0·22 | 7·12 ± 0·30 |
| Crude fat | 2·36 ± 0·74 | 3·62 ± 0·33 | 0·50 ± 0·17 | 0·53 ± 0·18 | 0·03 ± 0·00 | 0·04 ± 0·01 |
| Carbohydrate | 19·3 ± 3·25 | 18·2 ± 1·61 | 54·6 ± 1·17 | 48·6 ± 3·83 | 77·7 ± 0·54 | 77·0 ± 0·71 |
| Calorific value (kcal/100 g) | 332·90 ± 6·46 | 333·38 ± 3·18 | 314·14 ± 1·74 | 297·25 ± 6·49 | 332·75 ± 0·76 | 337·24 ± 1·01 |

[a]Values are means ± standard deviations of triplicate determinations.

hyperlipidaemia. It is suggested in the present study, that the higher moisture content of the defatted samples may be a quality problem in storage. The high lipid content of the undefatted samples may have the risk of leading to rancidity, but this could be prevented by the addition of rancidity inhibitors such as natural antioxidants (vitamin E or tocopherol and citric acid) and synthetic antioxidants (butylated hydroxy toluene, BHT, and butylated hydroxy anisole, BHA). Rancidity could also be minimised by storing in a cool and dark environment. Although the high level of lipids in the undefatted soup thickeners may lead to hyperlipidaemia when eaten excessively, the amounts usually consumed in soups are not high enough to cause nutritional problems. The calorific values of 521·54 kcal (raw undefatted melon), 673·81 kcal (raw undefatted dikanut) and 325·54 kcal (raw undefatted cocoyam) indicate that 504 g, 391 g and 808 g of these samples would respectively provide 2630 kcal, 2631·2 kcal and 2630·4 kcal. These values fall within the daily energy requirement of 2500–3000 kcal reported for adults by Bingham (1978).

From the study, it was evident that melon showed a better nutritive value when compared to dikanut and cocoyam and is thus recommendable for cooking. After defatting it had a much higher protein content, which could serve as a supplement to diets low in protein, thereby reducing the incidence of kwashiorkor especially in young children and pregnant mothers. As with dikanut, the high level of oil in melon can be exploited for use in the manufacture of edible oils, creams and soaps; it congeals on exposure to air probably due to the presence of saturated fatty acids. Protein–calorie malnutrition is a serious problem in Nigeria. Foods designed to overcome protein malnutrition should be formulated from defatted and heat-processed material, but defatting should be discouraged in the context of calorie malnutrition.

The potential of these widely consumed local soup thickeners as sources of functional proteins is under investigation.

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