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Suitability of high-yielding cowpea cultivars for koose, a traditional fried paste of Ghana

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Abstract *Cowpeas are important in the West African diet as an inexpensive source of protein. Several high-yielding and disease-resistant cultivars have been, or will be, released in Ghana. Koose is a popular cowpea food in Ghana, similar to the Nigerian akara. It is prepared by whipping a ground paste of cowpea, onion, pepper and salt to a foamy batter and frying it in groundnut or palm oil. Preparation of koose as a roadside snack provides a source of income for women. This study evaluated the major operations in the process for their impact on yield and profitability, and assessed the suitability of five newly released high-yielding cultivars for koose. The major factors influencing yield and profitability were: dry matter losses due to soaking of cowpeas; specific volume of whipped batter as affected by whipping efficacy, level and moment of salt addition, and extent of protein degradation and solubility; consumption of oil, which is not significantly affected by frying temperatures, but which depends on the number of times oil is reused. With a standardized laboratory process for making koose, the cultivars Ayiyi, Bengpla (both white), Asontem, Amantin and CR-06-07 (all red) were compared. Using objective criteria Bengpla scored highest, particularly on foam capacity of batter and specific volume of koose. In sensory panel tests CR-06-07 was preferred. Both cultivars were evaluated by roadside koose producers in comparison with local white cowpeas. They rejected CR-06-07 for its poor foaming and difficulty of dehulling but they agreed with our objective tests and rated Bengpla better than the local white cowpeas. As Bengpla is not yet widely available its dissemination should be promoted.*

Keywords: high-yielding, breeding, cowpea, koose, akara, acceptability.

Introduction

In Ghana 'koose' is a bean cake made by frying cowpea (*Vigna unguiculata*) paste. Traditionally associated with the Muslims of northern Ghana, it is now found in all urban areas. Cowpeas are a well accepted, relatively inexpensive source of dietary protein in West Africa (Sefa-Dedeh and Yiadom-Farye 1988) and koose is an attractive snack or side dish. Its preparation (Figure 1) involves coarsely grinding dry cowpeas, steeping, washing and rubbing to remove testae, adding onions and peppers, fine milling, whipping, adding salt and frying in groundnut or palm oil. Local cowpea cultivars with white and red testae are used, and several higher-yielding and insect- and disease-resistant cultivars have been developed.

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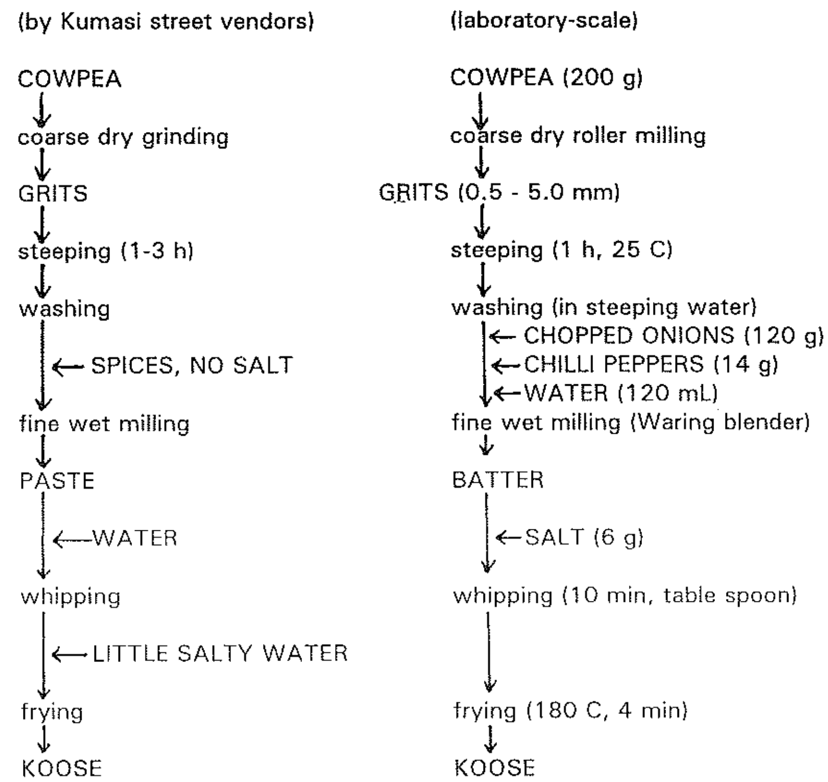

Figure 1. Preparation of koose

Preparation and selling of koose at the roadside can be a lucrative job for women. Interviews of several small-scale producers in Kumasi revealed that various ingredients, recipes and techniques are used, and these give rise to variable product quality and profitability. The local white cultivar is prized by producers for its soft testa, which can be removed simply by rubbing by hand or by mortar and pestle. However, the local white cultivar is also more expensive, about 135–150% of the price of red and some improved white cultivars. Major factors affecting consumer acceptability and profitability were identified as 'dough extension or foaming capacity' resulting from whipping the paste, and 'oil absorption' resulting from deep-frying in vegetable oil.

The aims of this project were to study the impact of the process operations on koose quality and profitability, and to assess the suitability of five relatively new high-yielding cowpea cultivars for their koose-making suitability.

Materials and methods

Cowpeas

The following improved cultivars were obtained from the Crops Research Institute, Kumasi. White testa: Ayiyi and Bengpla; Red testa: Asontem, Amantin and CR-06-07. Bengpla and Asontem cultivars were used for process optimization experiments.

Koose making procedure optimized at laboratory scale

This is outlined in Figure 1. Dry cowpeas (200 g) were coarsely ground in a roller mill (Daub & Verhoeven, The Netherlands, type 6246) with a 5 mm gap, to give particles of 0·5–5·0 mm. These were soaked for 1 h in 1 litre tap water at 25°C, and then rinsed with the soak water to remove testae by flotation. The weight of soaked peas was approximately 360 g. These were finely milled in a Waring Commercial Blender with 120 g chopped onions, 14 g chilli peppers and 120 ml water to obtain a homogenous batter with a volume of about 550 ml. This batter was whipped using a tablespoon for 10 min, just before frying, and 6 g table salt added. The volume of the whipped batter was roughly 800 ml. Ball-shaped amounts of the whipped batter were fried in sunflower oil at 180°C for 4 min until golden brown.

To evaluate the new cultivars, this process was modified for locally available equipment, and to suit local tastes. After coarse grinding with a Christy & Morris laboratory mill, white cowpeas were soaked 1 h and red cowpeas 2 h. To 300 g soaked peas, 90 g onions, 11 g pepper and 75 g water was added. The paste was allowed to stand 1–2 h at 28°C, whipped for 10 min with a wooden spoon and 5 g salt added. The batter was then fried in palm oil at 180–190°C for 4 min.

Analysis

Dry matter content was measured gravimetrically after drying for 24 h at 105–110°C in a ventilated hot air oven. On the basis of dry matter contents of dry cowpeas (i), soaked peas (ii), soaked seed coats (iii), and soak water (iv) and their absolute weights, a dry matter balance was calculated.

The micro-Kjeldahl method was used to measure crude protein, with a conversion factor of 6·25.

Fat absorption was measured by the method of Osei-Yaw and Powers (1986).

To measure the specific volume of fried koose, koose balls were weighed, and their volume measured by water displacement in a measuring cylinder. The foaming capacity was assessed by putting about 200 ml batter into a graduated transparent beaker and whipping with a spoon for 10 min. The foaming capacity (%) was calculated as FC = {(volume whipped – volume before whipping)/(volume before whipping)} × 100 (Padmashree *et al.* 1987).

Sensory evaluation of koose was undertaken by 12 trained Ghanaian adults familiar with the product, on a five-point hedonic scale for texture (1 = not light to 5 = very light and fluffy) and colour (1 = not attractive to 5 = very attractive). Paired preference tests were performed. Samples were supplied according to a randomized scheme.

After the laboratory assessment, two cultivars were evaluated by three koose producers from the Kumasi area, together with the cultivar they usually processed. The cultivars tested were Bengpla (best objective results) and CR-06-07 (best subjective scores).

Statistics

The objective results were assessed using the *t* test (Snedecor and Cochran 1980); hedonic scores were evaluated by one-way analysis of variance and *t* test (Snedecor and Cochran

1980). For the paired preference test, scale values were obtained by addition of z values, and were validated as linear function of preferences by Chi-square test (Jellinek 1985).

Results

Prolonged soaking resulted in significantly higher losses of dry matter (Table 1). Losses were similar regardless of whether tap water or soak water were used for rinsing.

Table 1. Dry matter losses due to soaking

Soak time (h)	Rinse	Percentage of total dry matter lost*
1	Soak water	3·53/4·81a
7	Soak water	8·12/9·29b
1	Tap water	5·94/5·01a

*Duplicate values
Data followed by different letters are significantly different (P<0·01, one-tailed test).

The type of whipping equipment affects the foam volume attained (Table 2). Using the electric blender produced twice as much foam volume as using a whisk. Whipping by spoon also gave significantly better results than using a whisk.

Table 2. Effect of whipping equipment and time on foaming capacity (%)*

	Equipment used		
Time (min)	Tablespoon	Whisk	Blender
1	20/24a	13/19b	50/55c
5	52/50d	40/41e	125/135f
10	88/88g	67/67h	200/210i
15	90/88g	65/70h	204/200i

*Duplicate values
Data followed by different letters are significantly different (P<0·01, one-tailed test).

The limited data on the effect of salt addition (Table 3) could not be tested for statistical significance, but foaming capacity (FC) tended to decrease as amount of salt increased. Although ageing of the batter for up to 6 hours did not significantly affect FC (data not shown), prolonged fermentation of the batter resulted in acidification and unacceptable off-smell (Table 4), and whipping of the fermented batter did not produce a foam. Simulation of

Table 3. Effect of salt on foaming capacity*

Amount of salt (g/150 g batter)	Foaming capacity (%)
0	153
1·6	100
2·3	87
3·0	80

*Whipping with tablespoon for 10 min.

Table 4. Effect of fermentation at 22°C of the batter on foaming capacity*

Fermentation time (h)	Batter pH†	Foaming capacity (%)†
1	6·35	125/133a
3	6·35	95/110a
22‡	4·40	0/0b

*Whipping with tablespoon for 10 min.
†Duplicate values.
‡After 22 h fermentation, the batter had a sour and putrid off-smell.
Data followed by different letters are significantly different (P<0·01, one-tailed test)

Table 5. Effect of pH of batter on foaming capacity*

pH†	Foaming capacity(%)‡
6·05	117/111a
4·90	117/94a
4·00	25/21b

*Whipping with tablespoon for 10 min.
†pH adjusted with HCl.
‡Duplicate values.
Data followed by different letters are significantly different (P<0·01, one-tailed test).

this acidification, by adding HCl to a freshly prepared batter to pH 4, significantly reduced FC (Table 5).

A strong decrease of FC was also observed when using cowpeas which had been allowed to germinate before processing (data not shown). Other factors, such as the amount of onions and peppers added, and addition of water (120–150 ml/200 g dry cowpeas) had no significant effects on the FC.

There was no significant difference in oil absorption (47–50% on dry matter basis) during frying at temperatures of 145–180°C.

Although moisture and crude protein contents were similar in all the varieties tested (Table 6), the white cowpeas (Ayiyi and Bengpla) gave significantly higher FC values. The resulting fried koose balls were similar in moisture and fat contents but there were small but significant differences in crude protein content, and the white cowpeas and CR-06-07 had significantly higher specific volumes.

No significant differences were observed in colour and texture between the cultivars (Table 7), but there was a significant preference for CR-06-07. Asontem was significantly rejected.

Table 8 summarizes the views of the three koose producers about the suitability of Bengpla and CR-06-07 compared with white local cowpeas. Except for its somewhat more difficult dehulling, Bengpla was rated as superior on foaming, taste and absence of insect damage, but it is difficult to obtain. One of the women had not used Bengpla before and wanted to know where it could be bought. Although CR-06-07 scored best in the sensory tests, it was described as less suitable for making koose because it is difficult to dehull, has poor foaming and does not have a very special taste.

Table 6. Objective assessment of high-yielding cowpea cultivars

	Ayiyi	Bengpla	Asontem	Amantin	CR-06-07
Raw cowpeas (n = 2)					
Percentage moisture	12·17	12·85	12·93	13·09	12·08
Crude protein (% dry matter)	24·88	26·60	25·50	24·17	24·20
Batter (n = 6)					
Foam capacity (%)	38·3(4·2)a	41·7(1·4)a	37·5(2·5)b	38·3(1·5)b	36·6(2·8)b
Koose (n = 6)					
Percentage moisture	52·9(3·3)c	54·0(4·4)c	48·6(3·6)c	51·5(1·5)c	48·4(2·8)c
Crude protein (% dry matter)	14·05(0·22)d	14·19(0·18)d	13·34(0·01)e	15·15(0·36)f	15·26(0·17)f
Fat absorption (% dry matter)	43·7(6·3)g	41·1(4·7)g	43·4(8·1)g	36·2(6·9)g	43·8(8·2)g
Specific volume (ml/g)	1·92(0·18)hi	1·98(0·15)h	1·72(0·09)i	1·66(0·19)i	1·80(0·09)hi

Values in parenthesis represent standard deviation.
Data followed by different letters are significantly different (P<0·01, one-tailed test).

Table 7. Subjective evaluation of high-yielding cowpea cultivars

	Ayiyi	Bengpla	Asontem	Amantin	CR-06-07
Hedonic five-point scale (n = 12)					
Texture	3·25(0·96)a	3·33(0·79)a	2·5(0·90)a	2·9(1·16)a	2·5(0·79)a
Colour	3·7(1·37)b	3·5(1·00)b	3·4(1·31)b	4·3(1·06)b	3·9(0·99)b
Paired preference test					
Scale value	0·316	0·394	0	0·354	0·486
Order of preference	4c	2c	5d	3c	1e

Values in parenthesis represent standard deviation.
Data followed by different letters are significantly different (P<0·01, one-tailed test).

Table 8. Evaluation of high-yielding cowpea cultivars by three koose producers

	White local (n = 3)	Bengpla (n = 3)	CR-06-07 (n = 1)
Availability	Abundant	Scarce	
Dehulling	Easiest	Less easy	Very difficult
Foam capacity	Medium/good	Very good	Poor
Taste	Popular/good	Equal/better than white local	Fair
Insect damage	Poor quality	Very good	
Price	High	High	

Discussion

Profitability of koose making is determined by yield, foam yield, time requirements, and oil use. Dry matter losses due to soaking can be reduced by reducing soaking periods and rinsing with soak water. Foam volume and stability are important criteria for koose making (Ngoddy *et al.* 1986; Sefa-Dedeh and Yiadom-Farye 1988): the higher the foam volume, the better the yield. Although the Hobart electrical mixer gave the best results, in the standard process whipping was carried out with a tablespoon as this is also done by the Ghanaian koose producers.

The negative effect of salt on foaming capacity indicates that the quantity of salt should be minimized to the amount required for taste. Adding salt after whipping apparently had a less detrimental effect than adding salt together with the other ingredients before grinding the batter (data not shown).

Microbial fermentation may be essential for batter formation in koose manufacture (Marfo *et al.* 1990). Microbial fermentation of cowpeas reduces antinutritional factors, including phytic acid (Akpapunam and Achinewhu 1985), raffinose and stachyose (Bulgarelli and Beuchat 1990). As a result of considerable growth of lactobacilli during 12-24 h fermentation of cowpea paste, titratable acidity and water-soluble nitrogen compounds increase (Bulgarelli *et al.* 1988; Bulgarelli and Beuchat 1990). Our experiments aimed to assess the importance of microbial fermentation in the quality of koose. Overnight fermentation resulted in loss of foaming capacity and development of off-flavours. The effect on foaming capacity could be reproduced by adjusting the pH of freshly prepared cowpea batter to pH 4.00. The isoelectric point of the soluble proteins is about pH 4, so their solubility will be lowest at this pH (Giami 1993) and their contribution to foam formation and stability will be less. Thus, prolonged fermentation is undesirable in the koose process. Additional reasons would be the observed flavour defects, as well as the risk of accumulation of biogenic amines (Nout *et al.* 1994).

The detrimental effect of cowpea germination on foaming capacity observed can be explained by the proteolysis taking place during germination. A similar result was obtained by Bulgarelli and Beuchat (1990).

Frying conditions do not affect oil consumption, but the number of times oil is reused is important for profitability.

Using the standardized laboratory-scale process, the white cultivars scored better on foaming capacity. With equal fat absorption, this would indicate that Bengpla would have the highest potential for profitability. The subjective evaluation revealed a (surprising) significant preference for CR-06-07 followed by Ayiyi, Bengpla and Amantin. There was no single reason why CR-06-07 was preferred. Koose from Asontem scored badly because of its unpleasant taste, which was traced back to the taste of the cowpeas. It was interesting to note that koose producers, unknowingly, were in agreement with the objective measurements and rated Bengpla as better than local white cowpeas. This cultivar should be made available more widely than it is at present. CR-06-07 was regarded unsuitable on grounds which had not been included in the subjective sensory assessment.

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