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RESEARCH NOTE

Some biochemical and microbiological changes during dehydrated attiéké storage

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The shelf-life and quality of dehydrated attiéké packaged in polyethylene bags purchased from a local producer were evaluated during storage at 10·5%, 18·3% and 22% initial moisture contents. High moistures were obtained by adding a little sterile water to materials at 10·5% initial moisture level. Shelf life of attiéké stored at 10·5% moisture content was over four weeks compared to less than four weeks for higher moisture contents. Extension of shelf life was attributed to delayed microbial growth and slow biochemical changes. Biochemical changes due to the low-moisture storage appeared to be minor compared to those which occurred in high-moisture products. Insignificant biochemical changes resulted in products having acceptable eating quality for four weeks.

INTRODUCTION

Attiéké is a moist food (40–50% moisture) with a short shelf-life of 2–4 days (Traoré & Brizoua, 1981; Aboua, 1989). Fresh attiéké is one of the major processed forms of the cassava root widely consumed in Africa. It is a product like gari, now well known in the world. Its preparation consists of peeling, cutting, washing, adding a leaven (fermented cooked cassava), grinding the roots into a mash and fermenting for two days. The mash is pressed out to remove water, granulated and sieved, sun-dried and steam-cooked to a moisture level of about 40–50% (Traoré & Brizoua, 1981; Muchnik & Vinck, 1984; Aboua, 1988, 1989, 1990). Although shelf-life varies with the cooking time, the limiting shelf-life of fresh attiéké stored in a vegetable basket is usually less than a week (Aboua, 1989). For long-term storage, attiéké is sun-dried or oven-dried, milled into a coarse and fine semolina and packaged in a polyethylene bag. The dehydrated attiéké has 9–10% moisture to allow it to be stored for a long time. Although the manufacturers claim that the bags are impermeable to air, they are not vacuum-packaged, and hence contain some air between the attiéké itself and the bag walls. This results in oxygen in the bags favouring the growth of aerobic bacteria, yeasts and moulds. No information is available on storage- induced biochemical and microbial changes in attiéké. In our laboratory, interest has recently focussed on the shelf stability of dehydrated attiéké stored in polyethylene bags. The study reported here was designed to determine the chemical and microbial changes in dried attiéké kept in polyethylene bags for four weeks.

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MATERIALS AND METHODS

Packaging and storage

Freshly packed dried white attiéké samples of 350 g each (50 packs × 350 g) were purchased from a local producer. Each sample packed in a polyethylene bag by means of a kitchen packaging machine was stored at 30°C, to simulate Abidjan market conditions, and examined for four weeks. This attiéké had a 10·5% initial moisture content, Other attiéké samples were prepared by initially adding small amounts of sterile water to the dried attiéké until 18·3% and 22% initial moisture levels had been reached.

Microbiological studies

For total aerobic plate count, a plug of (10 g) dehydrated white attiéké was obtained, using a sterile borer, and homogenized with 90 ml of sterile 0·85% saline (initial dilution 10^{-1}) for 1 min. This mixture was homogenized with a stomacher for 2 min. From this homogenate, a series of dilutions (10^2, 10^3) were prepared. The number of colonies was determined on 15 ml gelose PCA using standard techniques. Incubation was done at 30°C for 72 h and triplicate counts were made.

For yeasts, colony types and moulds, 0·1 ml of each dilution was used. The numbers of yeast and mould col-

Table 1. Changes in chemical composition of dehydrated attiéké with storage time

Storage time (weeks)	Moisture (%)	pH	Total acidity (meq 100 g)	Lactic acid (%)	Starch (%)	Total sugar (%)	Reducing sugar (%)	Ash (%)
0	10·5	4·50	20	1·80	77·7	1·48	0·44	1·14
4	10·5	4·15	17·5	1·58	72·7	1·53	0·57	0·68
0	18·3	4·50	20	1·79	77·5	1·48	0·50	1·13
4	16·3	3·90	27·0	2·48	75·0	1·80	0·64	0·69
0	22	4·50	20	1·80	78·8	1·48	8·52	1·12
4	19·5	4·17	30	2·70	75·5	2·13	0·92	0·54

Table 2. Microbial counts of dehydrated attiéké stored at 30°C for 4 weeks

Microorganisms	Freshly packaged	Stored for 4 weeks		
	White attiéké at 10·5% moisture	Attiéké at 10·5% moisture	Attiéké at 18·3% moisture	Attiéké at 22% moisture
Total aerobic mesophilic bacterial count[a] on OCA at 30°C for 72 h	50	50	110	52 000
Moulds on OGA at 30°C for 72 h	0	0	0	0
Yeasts on OGA at 30°C for 72 h	0	0	0	0

[a] CFU/g of dry sample.

onies were determined on gelose-glucose with oxytetracycline (OGA) employing standard techniques. Incubation was done at 30°C for 72 h and triplicate counts were made. The microorganisms were identified by cultural, morphological and biochemical characteristics.

Sensory evaluation

Sensory quality of attiéké was evaluated by a panel consisting of five trained laboratory staff. They were asked to assess dried attiéké for colour, flavour and taste on a 5-point scale. For this sensory assessment, the dehydrated attiéké was moistened with an amount of water and left for 5 min to soften before steam-cooking for 10 min in the manner of couscous.

Chemical analyses

Chemical analyses for proximate composition were made according to procedures outlined by AOAC (AOAC, 1980).

Statistical analysis

Student's t-test was employed to analyse data for the significance of the degree of variation and the difference between treatments.

RESULTS AND DISCUSSION

Biochemical changes

As shown in Table 1, there was no change in moisture content (10·5%) of dried attiéké but slight decreases in pH, total acidity, lactic acid, starch and ash values were observed. A slight rise in total and reducing sugars of dehydrated attiéké was found during four weeks' storage. Results also showed significant chemical changes in samples of 18·3% and 22% initial moisture contents ($P < 0·01$). The moisture levels in polyethylene bags dropped from 18·3% to 16·3% or 22% to 19·5%, respectively, because water evaporated from the bags.

Other chemical changes were caused by the activities of the spoilage microorganisms and these activities were probably favoured by the high moisture storage.

Microbial changes

The microbial changes are shown in Table 2. There was no rise in microorganism number for attiéké at 10·5%, initial moisture content packaged in polyethylene bags during 4 weeks storage, but high moisture contents (18·3 and 22%) caused microbial growth. Total viable counts of fresh dried attiéké were significantly lower than those of packaged samples ($P < 0·01$). They ranged from 5×10^4 (fresh dried attiéké) to 3×10^4 CFU/g. Table 2 also reveals that there was no mould

Table 3. Changes in colour and flavour with storage time[a]

Storage time (weeks)	Attiéké at 10·5% moisture	Attiéké at 18·3% moisture	Attiéké at 22% moisture
0	4·9 (4·8)[b]	4·7 (4·5)	4·6 (4·1)
4	4·1 (3·5)	2·9 (2·5)	2·0 (1·6)

Score scale: 1, strongly unpleasant; 2 unpleasant; 3 moderate; 4, pleasant; 5, highly pleasant. Flavour scores are given in parenthesis. Significant changes in colour and flavour compared with fresh attiéké at 10·5% moisture ($P < 0·01$).
[a] Sensory scores were evaluated by a panel of 8 judges carrying out 3 replicates of each sample.
[b] Fresh attiéké.

Table 4. Changes in taste with storage time[a]

Storage time (weeks)	Attiéké at 10·5% moisture	Attiéké at 18·3% moisture	Attiéké at 22% moisture
0	4·7[b]	3·7	3·2
4	4·2	2·7	2·8

Score scale: 1, strongly unpleasant; 2 unpleasant; 3 moderate; 4, pleasant; 5, highly pleasant. Significant changes in taste compared with fresh attiéké at 10·5% moisture ($P < 0{\cdot}01$).
[a] Sensory scores were by a panel of 8 judges carrying out 3 replicates of each sample.
[b] Fresh attiéké.

or yeast growth in attiéké at 10·5, 18·3 and 22% initial moisture contents kept in polyethylene bags during four weeks storage. Several studies have reported that microbial colonies grew strongly in foods during high moisture storage (Oyeniran, 1981; Regez *et al.*, 1987; Ofuya & Akpoti, 1988; Wickham & Wilson, 1988; Aboua, 1989). The critical upper limit of microbial counts for the safety of attiéké was set at less than 3×10^4 CFU/g dry sample.

Sensory quality

A slight drop in average colour, flavour and taste scores found in dehydrated attiéké at 10·5% initial moisture content was not significant ($P < 0{\cdot}01$) (Tables 3 and 4). The average colour, flavour and taste scores ranged from 4·1 to 4·9, 3·5 to 4·8 and 4·2 to 4·7, respectively. This attiéké was highly pleasant and had a good eating quality. Attiéké of 18·3% moisture content had less-acceptable eating quality but corresponding figures for attiéké at 22% moisture levels were unpleasant. Although attiéké with 18·3% moisture content could be consumed, it is strongly recommended to eat it after reheating. Shelf-life of low-moisture attiéké was above four weeks. Spoilage occurred earlier in high-moisture attiéké (18·3 and 22%) and the average colour, flavour and taste scores were lower. Microbial colonies caused discoloration and complete deterioration of attiéké at over 10·5% initial moisture content. In this work, the acceptability score of attiéké in Tables 3 and 4 ranged from unpleasant up to highly pleasant.

CONCLUSIONS

Storage of fresh dehydrated attiéké at 10·5% initial moisture content resulted in fewer biochemical and microbiological changes than for materials at 18·3 and 22% initial moisture levels. Low-moisture storage extended the shelf-life four weeks longer than the high-moisture storage by slowing microbial growth and biochemical changes. Attiéké stored at 10·5% moisture content was acceptable up to four weeks compared to less than four weeks for the higher-moisture products.

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