SENSORY EVALUATION OF SOY FORTIFIED CASSAVA "FUFU" STORED AT VARIOUS RELATIVE HUMIDITIES AND DIFFERENT DURATIONS IN NIGERIA

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ABSTRACT
This study was carried out to determine the level of acceptance of soy-fortified fufu after storage in order to predict the shelf life of the product. The samples were exposed to the range of relative humidities(RH) that the products are marketed in Nigeria (i.e. RH 30 – 90%). Sensory evaluation was carried out by 20 trained home economic students at specific intervals. Results of the study showed that samples stored at 80 and 70 percent RH were very acceptable up to two and three months of storage respectively, while samples stored at 30% and 50% RH were acceptable up to seven months of storage. Samples stored at 90% RH on the other hand lost its sensory qualities within eight days. The shelf life of these samples can be extended if production of soy fufu at 12% moisture can be followed up with adequate packaging with thick gauge cellophane film.
Keywords: Soyfortified fufu, sensory evaluation, storage, relative humidities.

INTRODUCTION

Cassava, Manihot esculenta, crantz is one of the most productive crops in the tropical area of the world. It can grow in relatively poor soils, tolerates droughts, Is not seasonal and is reasonably resistant to insect pests (IITA, 1979) Nigerians of all income classes generally like cassava based foods and many of their meals are likely to include cassava in some from (April, 1974). Cassava is a cheap source of energy – especially for Nigerians in rural areas (Ikpi and Hahn 1988) and it constitutes a high portion of the carbohydrate intake in Nigeria. Reports from Raw Materials Research Development Council (RMRD, 2004), points to the possibility of cassava generating income for the largest number of households when compared with other staples.

Fufu is one of the major cassava products widely consumed in Nigeria and other African countries (Sanni 1999). Fufu production involves: peeling, washing, steeping (soaking in water for 3 days for fermentation), milling, sieving and packaging (RMRDC, 2004 and Uko 1992). Fufu is similar to lafun in processing – the main difference lies on the sieving, which is not part of lafun processing (Ikpi and Hahn, 1988). Several workers (Uko, 1992, Numfor, 1983, and Onyekwere 1989) have reported attempts at improving the nutritional status of fufu. Uko (1992) showed that fortification of fufu up to 12 percent with soybean was acceptable to students. This study is aimed at determining the optimal relative humidity at which a fortified fufu can be stored so that the self life can be extended. The information is relevant to students who are major consumers of fufun for household and bulk storage centres. It will help in ensuring the quality of fortified fufu thereby increasing income earnings, food intakes and household food security.

MATERIALS AND METHODS

Freshly harvested cassava (sweet variety, 4(2) 1425) was peeled washed and steeped in water for 48 hours. The tubers were thoroughly washed, grated and resteeped in water for 24hours. The mash was sieved in water, sundried and milled. Soybean flour was produced by roasting the cleaned soybean in a metal frying pan similar to that used in garri processing (Ijeoma, Okpokiri and Ukpabi, 1988). The soybean was then cooled to room temperature, and ground in a hammer mill. The flour obtained was sieved using an Endocotts Laboratory test sieve with 2.00mn aperture size. The product so obtained is free from the trypsin inhibitory factor (Ferrier and Lopez 1979). The cassava flour was fortified with soybean flour at different levels (%, 8%, 10%, 12% and 14%) by blending.

The fortified and unfortified fufu samples were earlier subjected to preliminary sensory evaluation by 20 trained Home Economics Students. Results of the sensory evaluation revealed that fufu can be

acceptable up 12% level of soybean (Uko 1992). Based on the above findings, storage studies were carried out on the fortified fufu over a period of seven months.

Fifty grams (50g) of each unfortified and fortified fufu sample was weighed in triplicates into Petri dishes and were placed on a wire gauze inside a desiccator. They were exposed to various Relative Humidity atmospheres (simulated in the laboratory) ranging from 30 to 90% maintained by saturated solution of potassium hydroxide (Buxton and Mellanby 1934). The number of grams of potassium hydroxide required to build up Relative Humidity (RH) corresponding to a required RH was obtained by extrapolation from the standard plot of RH against g HOH (Buxton and Mellanby, 1934). The Relative Humidities the fortified fufu samples were exposed were meant to represent the range of Relative Humidities that the products are likely to encounter during storage at home or distribution in Nigeria.

One hundred milligrams (100ml) of each Potassium hydroxide solution was placed in separate desiccators to build up air corresponding to their respective Relative Humidities. The Petri dishes containing the 50g samples in triplicates were placed on top of wire gauze previously placed in the desiccators. A thin film of Silicon gel was rubbed on the edge of the lids to ensure that the desiccators were airtight. The desiccators containing the fortified fufu samples were kept under atmospheric temperature ($27 + 2^0$C). Some soy-fortified samples were packed in an airtight container and stored in the freezer as the reference sample.

SENSORY EVALUATION

Samples were drawn for sensory evaluation every month (30 days). Twenty (20) trained Home Economic students were used for the sensory evaluation using the multiple comparison test method described by Larmond (1977). The fufu samples were presented to the panelists in identical coded dishes. Each of the trained panelists were presented with a tray containing one reference sample (i.e. fortified sample stored in the freezer), and 4 coded samples. The reference sample served as the control and was coded (R). The panelists were asked to evaluate these samples based on numerical scores assigned to the ratings. The scores ranged from 1-9. The evaluations were conducted in well-lit evaluation cubicles. Water was supplied for rinsing the mouth in between tasting. The samples were evaluated between 10am and 2pm. Colour, aroma, texture and overall acceptability of the soy-fortified fufu – stored at different Relative Humidities were assessed. All data were subjected to analysis of variance and differences between means by Duncan's New Multiple Range test procedure as outlined by Steel and Torrie, (1960).

RESULTS AND DISCUSSION

Tables 1 to 5 show the result of the storage studies at Relative Humidities (RH) of 30 – 80%. Samples stored at RH of 90% did not store beyond 8 days. At all the RH's studied, unfortified samples stored longer than the fortified samples. This could be due to the fat content of soybean. At RH's of 70 and 80% samples were still acceptable up to 2 and 3 months respectively. Beyond 3 months the sensory scores were significantly very low indicating the onset of deterioration. At lower RH's of 30 and 50%, results showed that the fortified samples were store up to 7 months.

Results also showed that there was progressive deterioration as signified by decrease in sensory attributes. Sensory scores for all the different RH's for the first month were higher than for the second month. The sensory scores were found to decrease with increase in duration of storage. This trend was also observed by Uko-Aviomoh (2000) with stored fortified gari. Results of this study showed that fufu stored longer at 70%RH than 80% RH. This may be due to the lower moisture content at 70%.

Table 1a: Mean scores of the Sensory evaluation of Unfortified Fufu stored at 30% RH

Duration of storage (months)

Sensory attributes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**SEM**
Colour	8.70c	8.62c	8.60c	8.51c	8.48b	8.02ab	7.67a	0.27
Texture	8.65b	8.60b	8.57b	8.53b	8.46b	7.96a	7.82a	0.25
Aroma	8.63b	8.59b	8.55b	8.50b	8.41b	8.03a	7.75a	0.27
Overall acceptability	8.69c	8.60c	8.57c	8.53c	8.40b	8.01a	7.79a	0.26

Values with the same letter are not significantly different (P>0.05)

Table 1b: Mean scores of the Sensory Evaluation of Fortified Fufu stored at 30% RH

Duration of storage (months)

Sensory attributes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**SEM**
Colour	7.79c	7.34c	6.98bc	6.54b	5.01a	5.55b	5.11a	0.28
Texture	7.91e	7.53e	7.29e	6.60cd	6.60cd	6.08b	5.65a	0.25
Aroma	7.78e	7.65e	7.09d	6.68cd	5.28ab	6.58b	5.06a	0.24
Overall acceptability	7.98e	7.81e	7.35d	6.80c	6.30b	5.76a	5.18a	0.20

Values with the same letter are not significantly different (P>0.05)

Table 2a: Mean scores of the Sensory Evaluation of Unfortified Fufu stored at 50% RH Duration of storage (months)

Sensory attributes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**SEM**
Colour	8.9ec	8.85e	8.50d	8.27d	7.95c	7.62b	6.21a	0.27
Texture	8.82e	8.73e	8.51de	8.20d	7.63c	7.02b	6.11a	0.26
Aroma	8.86f	8.61e	8.35d	8.16d	7.62c	7.21b	6.09a	0.26
Overall acceptability	8.57d	8.45d	8.01c	7.82c	7.75c	6.61b	6.18a	0.26

Values with the same letter are not significantly different (P>0.05)

Table 2b: Mean score of the sensory Evaluation of Fortified Fufu stored at 50% RH Duration of storage (months)

Sensory attributes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**SEM**
Colour	8.62f	7.92ef	7.30de	6.80cd	6.21bc	5.80b	4.91a	0.24
Texture	8.57f	8.01ef	7.44de	5.88c	6.18cd	5.51b	4.95a	0.25
Aroma	8.45f	7.75ef	7.14de	6.61cd	6.20c	5.47ab	4.82a	0.23
Overall acceptability	8.52f	8.43f	7.48de	6.17cd	6.20bc	5.65ab	5.21a	0.25

Values with the same letter are not significantly different (P>0.05)

Table 3a: Mean scores of the Sensory Evaluation of Unfortified Fufu stored at 70% RH Duration of storage (months)

Sensory attributes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**SEM**
Colour	8.82d	8.75d	8.70d	8.60d	7.75c	7.01b	6.68d	0.26
Texture	8.78f	8.62f	8.51de	8.32d	7.82c	7.11b	6.42a	0.25
Aroma	8.79f	8.60f	8.32e	8.01d	7.52c	7.22b	6.21a	0.25
Overall acceptability	8.51e	8.44e	8.37e	7.88d	7.23c	6.66b	6.01a	0.25

Values with the same letter are not significantly different (P>0.05)

Table 3b: Mean scores of the Sensory Evaluation of Fortified Fufu stored at 70% RH Duration of storage (months)

Sensory attributes	**1**	**2**	**3**	**4**	**SEM**
Colour	6.75b	6.70b	4.85ab	4.10a	0.24
Texture	6.73c	5.83bc	4.89b	3.46a	0.29
Aroma	6.61c	5.66bc	4.86b	4.11a	0.18
Overall acceptability	6.01c	5.96c	4.93ab	4.20a	0.17

Values with the same letter are not significantly different (P>0.05)

Table 4a: Mean scores of the Sensory Evaluation of Unfortified Fufu stored at 80% RH

Duration of storage (months)

Sensory attributes	1	2	3	SEM
Colour	7.25c	6.32b	4.01a	0.22
Texture	7.00c	6.14b	3.92a	0.23
Aroma	6.75c	6.01b	3.98a	0.23
Overall acceptability	6.50c	5.82b	3.85a	0.24

Values with the same letter are not significantly different (P>0.05)

Table 4b: Mean scores of the Sensory Evaluation of Fortified Fufu stored at 80% RH

Duration of storage (months)

Sensory attributes	1	2	3	SEM
Colour	5.51b	5.39b	3.14a	0.29
Texture	5.31b	5.01b	3.08a	0.25
Aroma	5.64b	5.44b	3.23a	0.23
Overall acceptability	5.43c	4.69b	3.73a	0.19

Values with the same letter are not significantly different (P>0.05)

The sensory scores obtained for fufu samples stored at 50% and 30% RH showed that fortified fufu was acceptable at 7 months of storage although the sensory scores were found to decrease with time. Fortified samples stored at 30% and 50% RH for 1 and 2 months were significantly ($p<0.05$) higher in overall acceptability scores than products stored for 3,4,5,6 and 7 months respectively. Again, the difference may be due to progressive absorption of moisture by the fortified products from the simulated environment. This may result in increased microbial growth over time. Microbial growth in turn can lead to off flavour and off colour of the fufu samples. Sensory scores (overall acceptability) for products stored at 70% RH for 1 month was significantly ($p<0.05$) higher than those stored for 2,3,4,5,6 and 7 months. The difference observed could be due to the higher moisture content at 70% which can favour enzymatic and microbial growth and may lead to changes in organoleptic properties. Samples stored at 90% RH got spoilt within 8 days and were discarded.

The result shows that there is need for packaging of food products especially fufu after production to extend its shelf life by keeping out moisture. In Nigeria, large quantities of processed food products are lost annually as a result of inadequate/poor storage facilities (Sanni, 1999, Uko-Aviomoh and Okoh 2005). It is more serious in the southern parts of Nigeria where the Relative Humidity is high for most part of the year. In Northern Nigeria, where the Relative Humidity (RH) is low, foods keep for a longer period of time. This study reveals that low Relative Humidity (RH) can help to store food for a longer period of time. This result confirms that earlier observation of Mazza (1982) who linked low RH to longer shelf life.

The study also revealed that fufu is hygroscopic in nature and is capable of absorbing moisture for the surrounding environment especially where high relative humidity prevails as is found in western and southern Nigeria. Samples stored better at low relative humidity than at higher relative humidity. Fufu is sold in open containers in the traditional and open markets. Fortification with soybean further made the fufu more susceptible to spoilage. The use of jute bags or Hessian bags (for traditional packaging of fufu) still exposes the products to spoilage. It is therefore important that the fortified fufu can be packaged with thick gauge cellophane films to keep out moisture and thereby extend the shelf life of the products.

REFERENCES

April, J.E., Hersh, G.N., Rogers, D.J. and Slater, C.C. (1974). Cassava, Role as Food Staple. Report prepared for office Nutrition. Bureau of Technical Assistance Agency for International Development, Boulder, Coloradp, pp1-10.

Buxton, P.A. and Mellanby, K. (1934). The Measurement and Control of Humidity. *Bulletin of Entomology Reassure* 25, 254-259.

Ferrier, L.K. and Lopez, M.J. (1979). Preparation of Full Fat Soyflour by conditioning, heating and grinding. *Journal of food science*, 44, 1017-1021.

I.I.T.A. (1979). International Institute for Tropical Agriculture. Proceedings of Cassava Mosaic Workshop Report, December 1979. I.I.T.A., Ibadan, 1-7.

Ijioma, B.C. Ogbuefi, C.R.A. and Okpojiri, A.O. and Ukpabi, U.J. (1988). Production of Protein Enriched cassava fufu flour. *Journal of Roots Crops* 14(2):11-14.

Ikpi, A.E., Hahn, N.D., (1988). "Cassava Development in Nigeria. In: Cassava: a Lifeline for the rural household. UNICEF House, Plaza, New York, (Eds: Ikpi, A.E. and Hahn N.D.) 1-3.

Larmond, E. (1977). Laboratory methods of Sensory Evaluation of Foods (Ed. Larmond, E.) Canada Publication, 1637. Department of Agriculture, Ottawa, 1-73.

Mazza, G. (1982). Moisture Sorption Isotherms of Potatoe slices. *Journal of Food Technology* 17, 47-48.

Numfor, F.A. (1983). An improved technique of processing cassava fufu. In: Tropical Root Crops Production and uses in Africa. Proceedings of the Second Triennial Symposium of the International Society for Tropical Root Crops African Branch Cameroon (Editors: Terry, E.R., Doku, E.V.; Arene, O.B. and Malungu, N.M.) 111-113.

Onyekwere, O.O. (1989). Various Levels of Cyanide in F.I.R.R.O. Cassava based Products. Paper delivered at the seminar on cyanide levels in cassava products I.I.T.A., Ibadan, 1-8.

Raw Material Research Development Council (RMRDC) (2004). marketing of Cassava. Reports on survey of agro raw materials in Nigeria. RMRDC: a maiden report. 10-15.

Sanni, L.O. (1999). Effect of processing methods on chemical, physiochemical and sensory qualities of cassava fufu: unpublished Ph.D. Thesis University of Ibadan, Nigeria. 240-243.

Steel, P.G.D. and Torrie, J.H. (1960). Duncan's new multiple range Test In: Principles and Procedures of Statistics. A Biometrical Approach. Second Edition McGram-Hill Book Company, New York.

Uko, E.E. (1992). Studies on the effect of age and variety on the quality of fresh and processed cassava. A Ph.D. thesis Department of Food Technology. Faculty of Technology, University of Ibadan, Nigeria. 170-180.

Uko-Aviomoh, E.E. (2000). Studies on the effect of Duration of Storage on the Sensory Attributes of Soy garri. *African Journal of Education.* 5(2), 82-91.