Plant Foods for Human Nutrition **56:** 23–36, 2001.

Survey of Fura production in some northern states of Nigeria

VICTORIA A. JIDEANI[1,*], IRO NKAMA[2], EDIGA B. AGBO[1] and ISRAEL A. JIDEANI[1]

[1]*Biological Sciences Programme, Abubakar Tafawa Balewa University, P.M.B. 0248, Bauchi, Nigeria;* [2]*Department of Food Science and Technology, University of Maiduguri, P.M.B. 1069, Maiduguri, Nigeria* (**E-mail: vjideani@atbu.edu.ng*)

Received 6 May 1999; accepted in revised form 24 July 2000

Abstract. The objective of this research was to conduct a survey related to the production process for fura. Fura is a staple food for the Fulanis and Hausas. The single most important cereal grain for fura production is millet. A significant difference exists among respondents on the variety of millet chosen for fura production. A significantly ($p = 0.05$) greater proportion indicated that 'gero' is the variety in common use. Spices are indispensable as an ingredient in fura production with ginger being the single most important spice ($p = 0.01$). The traditional pounding method for processing millet into flour is still very much used. The implication of this is highlighted and a possible solution of optimizing the fura production process is recommended. Strictly speaking, fura is distributed with a minimum of packaging. The choice of suitable packaging provided protection during a generally short shelf-life and for local distribution. With increasing influence of advertising upon customers, small food processing enterprises making fura will have to improve the packaging and preservation of their products if they are to survive the competition.

Key words: Cloves, Fura, Ginger, Millet, Packaging, Shelf-life

Introduction

In tropical Africa, cereal grains are milled and used to produce thick porridges which are known by various names in different parts of the continent. In west Africa particularly in Nigeria, Ghana and Burkina Faso, one such thick porridge is called 'fura' – a semi- solid dumpling cereal meal [1]. Fura is produced mainly from moist pearl millet flour, blended with spices, compressed into balls and boiled for 30 minutes. While still hot, the cooked dough is worked in the mortar with the pestle (with addition of hot water) until a smooth, slightly elastic, cohesive lump (fura) is formed. The fura dough is rolled into 25–30 g balls by hand and dusted with flour. The fura is made into porridge by crumbling the fura balls into fermented whole milk (kindrimo) or

fermented skim milk (nono) [1, 2]. Sugar may be added to taste. The mixture is called ‘fura da nono’ in Nigeria. It is a popular mid-day meal.

Fura is produced at home both for family and commercial consumption. The producers of fura still use the traditional method of mortar and pestle both to dehull the grain and to reduce the dehulled grain into flour. Fura is typically distributed with minimum packaging. Processors and retailers of fura are primarily concerned with reducing waste and having a container for their food. Fura has a limited shelf-life of one day at ambient temperature [3]. Usually, a day after production, fura shows visible mold growth on the surface. The short shelf-life has always been a major deterrent to large-scale production. Thus, improving the processing, packaging and storage life of fura are of interest before food manufacturers can think of large scale production. However, not much is known about the traditional production process. This study was conducted to ascertain the effects of the fura production process. The information obtained will be useful for food manufacturers and serve as a basis for improving this process.

Materials and methods

Survey area. States in northern Nigeria chosen for the study included Adamawa, Bauchi, Borno, Gombe, Jigawa, Kano and Yobe. These are the major fura producing and consuming states in Nigeria.

Instrumentation. The survey was in the form of a structured questionnaire. The questionnaire was designed and pretested before being distributed to the potential respondents. The questionnaire was divided into 9 sections. Section 1 covered the demographic information about the respondents such as state of origin, gender, age, educational status, ethnic group and status with respect to fura production. Section 2 was developed to obtain information on raw materials used in producing fura. Section 3 was developed to ascertain the primary processes (i.e. the processes to which the cereal grain is subjected with the products still not directly consumable) the grains undergo during fura production. Section 4 contained questions to enabled researchers to determine the secondary processing (i.e. the processes the end product of primary processing, (flour) undergoes to obtain the product fura). Section 5 was used to obtain information on the equipment used, including cost. Section 6 provided a means of determining the cost of inputs, packaging, mode of display, shelf-life, preservation methods and signs of spoilage. Section 7 was used to gather data on product utilization and special attributes associated with fura, if any. Information on the by-products and personnel (manpower) needed during fura production was collected through questions in sections 8 and 9.

Table 1. Demographic characteristics related to the processor/retailer/consumer status of the respondents[a]

		Status				
		Processor/ Retailer n = 274	Processor/ Consumer n = 171	Consumer n = 320	Total n = 765	*p*-value[b]
(a)	Education					
	None	187 (68.2)	56 (32.7)	66 (10.0)	309 (40.4)	
	Primary	66 (10.9)	38 (22.2)	45 (14.1)	115 (15.0)	0.29
	>Secondary	0 (0)	82 (69.0)	259 (80.9)	341 (44.6)	
(b)	Ethnicity					
	Kanuri	7 (2.6)	24 (14.0)	24 (7.5)	55 (7.2)	
	Hausa	115 (42.0)	66 (38.6)	174 (54.4)	355 (46.4)	0.05
	Fulani	111 (40.5)	47 (27.5)	63 (19.7)	221 (28.9)	
	Others	24 (8.8)	29 (17.0)	81 (25.3)	134 (17.5)	
(c)	Age					
	≤ 25	56 (20.4)	70 (40.9)	130 (40.6)	256 (33.5)	
	26–35	97 (35.4)	47 (27.5)	163 (50.9)	307 (40.1)	0.04
	36–45	40 (14.6)	8 (4.7)	10 (3.1)	58 (7.6)	
	> 46	25 (9.1)	17 (4.1)	16 (5.0)	58 (7.6)	
(d)	Sex					
	Female	211 (77.0)	116 (67.8)	163 (50.9)	490 (64.0)	0.28
	Male	27 (9.8)	47 (27.5)	201 (62.8)	275 (35.0)	

[a] Figures in parentheses are percentages.
[b] Kruskal–Wallis one-way ANOVA test.

Data collection and analysis. A total of 900 questionnaires were distributed to processors, retailers and consumers of fura in Adamawa, Bauchi, Borno, Gombe, Jigawa, Kano and Yobe states. The questionnaires were completed by the respondents in their homes, markets and offices. There was agreement on when the completed questionnaires could be picked up. Where the respondents could not speak English, interviews were conducted in the local language with the assistance of an interpreter. Questionnaires (765) representing 85% were retrieved. The remaining 15% were either reluctant to return their questionnaire or could not be located.

Data from the questionnaires were analyzed using Microsoft Access [4] and tabulated as percentages. The Kruskal–Wallis H test (a nonparametric one-way ANOVA) and Mann–Whitney U test (a nonparametric alternative to the t-test) [5] were used whenever appropriate to compare the data.

Results and discussion

Demographic characteristics of the respondents. Demographic characteristics of the respondents are presented in Table 1. A total of 765 persons responded to the questionnaire. Processor/retailers were those who produced fura and either hawked it or sold it on a wholesale basis. Those who did not process fura but bought it from the processor to sell were also surveyed. Processor/consumers were those who produce fura for consumption purposes. Consumers were those not involved in processing but purchased fura for consumption. The respondents were comparable in most demographic characteristics ($p > 0.05$, for any variable), except for ethnicity and age. Of the respondents, 87.9% of those directly involved with processing and retailing of fura did hot have a formal education. This may contribute to improper hygiene practices during production and handling of fura which could lead to products with potential health hazards to the consumer. A significantly greater proportion of the processor/retailers and consumers of fura were Hausas, followed by the Fulanis ($p = 0.05$). Fura was a staple food for both Fulanis and Hausas. Wherever there was a settlement of the these tribes, fura was marketed. A majority of the fura dealers were 25 to 35 years old. Quite a number of the dealers were young girls, less than 15 years of age. About 73% of fura processors were females. The processing and marketing of fura is known to be a woman's trade. No male considered himself to be a processor. Those men who knew the processing method for fura either watched their mothers make it when they were younger or watched their wives. It was, however, surprizing to note that there were some men who were retailers (9.8%); 27.5% were processors/consumers. More men (62.8%) consumed fura compared to women (50.9%). Men are usually the breadwinners in Africa and in these cultures have the right to spend their money however and whenever they want. The women, who, in this culture, depend on what is made available to them by their husbands, are concerned primarily with the feeding of the family and, therefore, would have limited money to purchase fura for consumption except when the female has made it part of the family menu.

Raw materials and ingredients for fura production. Table 2 data include the major raw materials and ingredients used for fura production. All the respondents (100%) indicated that millet was the major raw material for fura production. Respondents (72.4%) indicated that there were two varieties of millet, while 25% indicated that there were three varieties used. The number of varieties of millet varied from one state to another. For instance, in Bauchi state, there were three varieties of millet in the market. These were 'gero', 'dauro or maiwa' and 'gayamba'. In the other states, gero and dauro were very common. A significant difference exists among respondents on the

Table 2. Major raw materials and ingredients used for fura production[a]

Question	Status: Processor/ Retailer n = 274	Processor/ Consumer n = 171	Consumer n = 320	Total n = 765	*p*-value[b]
(a) Major grain					
Millet	274 (100)	171 (100)	320 (100)	765 (100.0)	>0.05
(b) Variety in common use					
Gero	252 (92.0)	150 (87.7)	290 (90.6)	692 (90.5)	0.00
Dauro or maiwa	18 (6.6)	17 (9.9)	21 (6.6)	56 (7.3)	
Substitute grain					
(c) Can a substitute be used					0.05
Yes	219 (79.9)	128 (74.8)	253 (79.1)	600 (78.4)	
No	55 (20.1)	43 (25.1)	63 (19.7)	161 (21.1)	
(d) Grain used					0.05
Sorghum	128 (46.7)	110 (64.3)	192 (60.0)	430 (71.7)	
Rice	65 (23.7)	18 (10.5)	31 (9.7)	114 (14.9)	
Maize	26 (9.5)	0 (0)	30 (9.4)	56 (7.3)	
Others					
(e) Reasons for substitute					0.03
• unavailability of millet	209 (76.3)	132 (77.2)	254 (79.4)	595 (77.8)	
• choice	44 (16.0)	10 (5.8)	18 (5.6)	72 (9.4)	
• economy	10 (3.6)	0 (0)	9 (2.8)	19 (2.5)	
(f) Other ingredients used					0.02
Ginger	25 (9.1)	17 (9.9)	22 (6.9)	64 (8.4)	
Pepper	17 (6.2)	8 (4.7)	7 (2.2)	32 (4.2)	
Ginger/pepper/cloves	24 (8.8)	75 (43.8)	37 (11.6)	136 (17.8)	
Ginger/pepper	191 (69.7)	58 (33.9)	225 (70.3)	474 (62.0)	
Ginger/pepper/sugar	16 (5.8)	8 (4.7)	15 (4.7)	39 (5.1)	
(g) Proportion added					0.44
Small	210 (76.6)	57 (33.3)	0 (0)	267 (34.9)	
Ginger/pepper					
1:1	32 (11.7)	0 (0)	68 (21.2)	100 (13.1)	
2:1	16 (5.8)	29 (17.0)	68 (21.2)	113 (14.8)	
3:1	0	14 (8.2)	0 (0)	14 (1.8)	
4:1	0	14 (8.2)	34 (10.6)	48 (6.3)	
Ginger/peper/cloves					
4:1:1	0	0 (0)	24 (10.6)	34 (4.4)	
2:1:2	0	14 (8.2)	0 (0)	14 (1.8)	
1:1:1	0	14 (8.2)	0 (0)	14 (1.8)	

Table 2. Continued

Question	Status: Processor/ Retailer n = 274	Processor/ Consumer n = 171	Consumer n = 320	Total n = 765	*p*-value[b]
Ginger:pepper:sugar					
2:1:1	0	14 (8.2)	68 (21.2)	82 (10.7)	
(h) Commonest spice					0.01
Ginger	158 (57.7)	87 (50.9)	172 (53.8)	417 (54.5)	
Ginger/pepper	61 (22.3)	38 (22.2)	82 (25.6)	181 (23.7)	
Ginger/cloves	0 (0)	0 (0)	8 (2.5)	8 (1.0)	
Cloves	21 (7.7)	10 (5.8)	0 (0)	31 (4.0)	
Pepper	33 (12.0)	38 (22.2)	40 (12.5)	111 (14.5)	
(i) Spices added other than for flavor					0.05
Yes	8 (2.9)	8 (4.7)	34 (10.6)	50 (6.5)	
No	263 (96.0)	156 (91.2)	276 (86.2)	695 (90.8)	
Purpose					
• quickens appetite	1 (0.4)	0 (0)	15 (4.7)	16 (2.1)	
• medicinal	0	0 (0)	14 (4.4)	14 (1.8)	
• avoid constipation	0	0 (0)	7 (2.2)	7 (0.9)	

[a] Figures in parentheses are percentages.
[b] Kruskal–Wallis one-way ANOVA test.

millet variety chosen for fura production. A significantly ($p = 0.05$) greater proportion indicated that gero was the variety in common use.

Although millet was the major cereal used for fura production, some other grains can also be used alone or in combination with millet. Among the other grains used, sorghum was a more common choice ($p = 0.05$). The most frequent reason ($p = 0.03$) given for the choice of an alternate grain was unavailability of millet. Other reasons included (i) the processors choice; (ii) not sufficient money to purchase millet or (iii) to improve the quality of the fura. Other ingredients (Table 2) added to the cereal flour for fura production were ginger, pepper, cloves and sugar. These are either added alone or in combination. Sugar was added as a sweetener. Ginger, pepper and cloves are added as spices. There was a significant ($p = 0.02$) difference in the choice of these ingredients. The ginger and pepper combination was the most common or ginger alone when a combination was not desired. Thus it appeared that ginger was an indispensable ingredient in fura production. The proportion of these spices added was generally small. However, some of the respondents who estimated the ratio of the mixture gave 2:1 for ginger:pepper; 4:1:1 for

ginger:pepper:cloves and 2:1:1 for ginger:pepper:sugar. There was, however, no significant ($p = 0.44$) difference in the proportion of these spices.

A significant ($p = 0.05$) proportion (90.8%) of the respondents indicated that the spices were added mainly for flavor purposes. However, 6.5% of the respondents gave other reasons why these spices were added. These reasons included (i) the spices increase appetite, (ii) the spices are medicinal and (iii) they help to avoid constipation. According to the U.S. Food and Drug Administration (FDA) [6], a spice is 'any aromatic vegetable substance in the whole, broken, or ground form which is used primarily to season food, rather than to contribute nutrients'. About forty-eight spices and herbs used for flavoring food also possess antimicrobial activity. These spices include cloves, ginger, pepper and nutmeg. Cloves (*Syzygium aromaticum*) are warm spicy, fruity, astringent, slightly bitter, with a warm numbing effect. Ginger (*Zingiber officinale*, Roscoe) is a rhizome of a perennial of the ginger family. It has pungent and sulphurous characteristic flavor. Red pepper (*Capsicum frutescens*), imparts a fiery taste due to a phenolic substance called capsaicin [6]. The levels of the spices added in fura are obviously not sufficient to produce a preservative effect. However, the properties of these spices, if used in an overall systems approach [7], could be effective in extending the shelf-life of fura.

Fura production process and its byproduct. The production process for making fura can be divided into primary and secondary steps (Figure 1). Primary steps are those to which the cereal grain is subjected but the product is still not directly consumable. The objective is to perform a clean separation of the pericarp (bran) from the rest of the grain. This involves cleaning the grain, moistening the grain, dehulling by pounding (first pounding), washing and draining, second pounding of the grain to meal and sifting. Inspite of the increasing number of dehulling machines, the producers of fura prefer the traditional hand pounding for dehulling the grain and producing the flour. Decorticating (dehulling) of the grain is achieved by pounding the moistened grain with the end of a heavy wooden pole (pestle) in a mortar to knock off the outer seed coat. The beaten mixture is then washed to separate the bran. The endosperm obtained is allowed to drain in a sieve (425 μm) for 15 to 20 minutes. During this time, the dehulled grain is softened (30–40% moisture) and is ready for the 'second pounding'. The spices and the softened grain are pound with intermittent sifting resulting in a flour with 30–36% moisture.

Secondary steps are those to which the end product of primary processing (flour) undergoes to obtain fura. These involve processes such as blending, forming, cooking, pounding and forming. Some flour is reserved for dusting the final product. The reserved decorticated grain is blended into the remain-

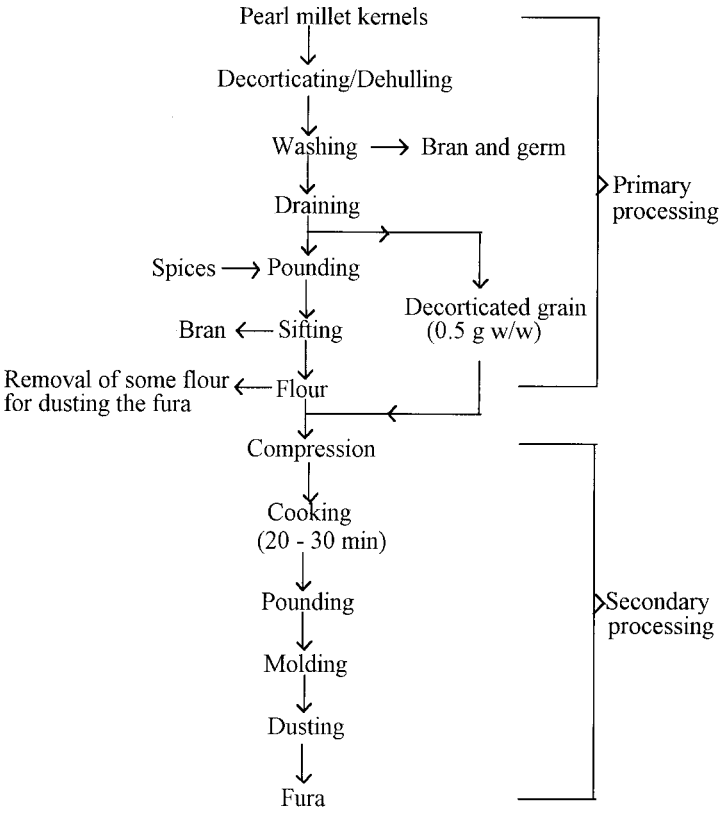

Figure 1. Fura production process.

ing flour. The wet flour (30–40% moisture) is compressed between the palms into a ball before dropping into boiling water. The balls are cooked for 25–30 minutes, pounded to a cohesive dough, while still hot, with addition of hot water as required. The dough is then rolled by hand into 25–30 g balls in a calabash and dusted with some flour resulting in the final fura.

An alternative method for making fura indicated by a few of the respondents follows the same process as outlined above up to the point of flour. The compression step is skipped. Instead, the flour is poured into the boiling water, covered and cooked for 20 to 30 min. The criticism against this method was that the fura gets overcooked easily, so it was not a very popular method.

The traditional pounding is a tedious task which limits the use of the cereal. Decorticating enough pearl millet for a family meal (about 2.5 kg) takes two women about 1.5 h; converting the product into flour with a mortar and pestle requires an additional 2 h, sometimes more [8]. Moreover, because the flour spoils quickly and cannot be put aside for later use, it has to be done

day after day each time fura is needed, in fair weather and foul, and regardless of sickness or other indisposition.

A majority of the respondents indicated that fura produced, using the traditional pounding method, tastes better and is preferred to that produced from the mechanized process. The reasons for this preference may be first, the consumers are so used to the traditionally produced fura that it is difficult to accept any change. Secondly, the moistening of the grain to facilitate removal of the bran and pounding into flour can result in a slightly fermented flour leading to a modified flavor [9]. They indicated that the mechanical process needs to be improved in such a way to produce flour similar to that produced by the traditional method. The major criticism of the mechanical process is that dry grain must always be used, producing flour that is too dry and when used, to produce fura, does not result in the same taste as the traditionally processed flour. However, these researchers believe that the production process for fura can be optimized. This was demonstrated that with the improvements in living standards in China, there has been quality requirements for traditional noodle products which have been retained in instant noodles [10]. Therefore, it should be possible to optimize fura production using mechanised dehulling and milling procedures. Such optimization, if achieved, would reduce the drudgery of women in fura eating areas, improve health and family welfare, convert millet into a much more convenient grain and lead to food manufacturers getting involved in production of fura. Moreover, with improvements in living standards in Nigeria and Africa at large, there has been an increasing demand for better quality food. Quality requirements for traditional fura should consequently change. At present, the burden of the terrible toil in millet processing is causing a silent rebellion against millet and the resulting fura.

Table 3 information shows the byproducts obtained from fura production and their monetary value. The majority (97.3%) of the respondents indicated that the bran is the major byproduct of fura production. It is used as feedstuff for animals. A great percentage of the respondents indicated that the bran has monetary value. A mudu ($\sim$ 0.5 kg) of bran can cost between 2–5 Naira and a bag of 50 kg can cost between 400 to 500. The waste water obtained from washing the bran off the endosperm is also given to the animals. Thus, production of fura is quite economical because nothing is wasted.

Packaging and distribution of fura. Table 3 data show the mode of packaging, marketing methods and duration of sale of a batch of fura [2.61 kg fura produced from 2 mudus of millet grain ($\sim$ 2.52 kg)]. Data from the processors/retailers and processors/consumers were related to marketing of fura since they are more involved in the selling of the product than the con-

Table 3. Byproducts from fura production, their monetary value and mode of marketing of fura[a]

	Status			
Question	Processor/ Retailer n = 274	Processor/ Consumer n = 171	Total n = 445	*p*-value
A. BY-PRODUCT				
Bran	266 (97.1)	167 (97.7)	433 (97.3)	0.32[b]
(i) Usage				
Feedstuff	212 (77.4)	167 (97.7)	379 (85.2)	
(ii) Monetary value				0.12
Yes	256 (93.4)	167 (97.7)	423 (95.1)	
No	9 (3.3)	0 (0)	9 (2.0)	
(iii) Price in Naira				1.0[c]
Per mudu, 2–5	92 (33.6)	122 (71.3)	214 (48.1)	
Per bag (50 kg), 400–500	148 (54.0)	30 (17.5)	178 (40.0)	
B. MARKETING OF FURA				
(a) Packaging material				0.14[c]
Leather	137 (50.0)	58 (33.9)	195 (44.5)	
None	57 (20.8)	25 (14.6)	82 (18.4)	
Others				
Calabash	73 (26.6)	33 (19.3)	106 (23.8)	
Bowl	0 (0)	24 (14.0)	24 (5.4)	
(b) Coated with flour				0.10[c]
Yes	265 (96.7)	167 (97.7)	432 (97.1)	
No	0 (0)	0 (0)	0	
(c) Reason for the coating				0.30[c]
Aesthetic	54 (19.7)	20 (11.7)	74 (16.6)	
Avoid sticking	124 (45.2)	52 (30.4)	176 (39.6)	
Reduce moisture loss	20 (7.3)	31 (18.1)	51 (11.5)	
Preservation	44 (16.0)	10 (5.8)	54 (12.1)	
Avoid cracking	10 (3.6)	30 (17.5)	40 (9.0)	
Prevent dust and flies infestation	12 (4.4)	19 (11.1)	31 (7.0)	
(d) Marketing method				0.85[c]
Hawking	242 (88.3)	100 (58.5)	342 (76.9)	
Wholesale	14 (5.1)	0	14 (3.1)	
Consumption	0 (0)	50 (29.2)	50 (11.2)	

Table 3. Continued

Question	Status: Processor/ Retailer n = 274	Processor/ Consumer n = 171	Total n = 445	*p*-value
(e) Where sold				0.85[c]
Market	221 (80.6)	97 (56.7)	318 (71.5)	
Home	35 (12.8)	58 (33.9)	93 (20.9)	
Garage	10 (3.6)	0	10 (2.2)	
(f) Duration of sale				0.68[c]
1–5 hrs	87 (31.8)	66 (38.6)	153 (34.4)	
1–2 days	173 (63.1)	88 (51.5)	261 (58.7)	

[a] Figures in parentheses are percentages.
[b] Mann–Whitney U test.
[c] Kruskal–Wallis one-way ANOVA test.

sumers. The respondents were comparable in their response to packaging material and method of distribution of fura ($p > 0.05$). All the respondents coated the cooked millet balls with flour in the production of fura. Many reasons were given for coating of the product with flour. These include aesthetics, preventing the balls sticking to each other, reducing moisture loss, preservation, avoiding cracking, and prevention of dust contamination and fly infestation of the product. In practice, the flour does not prevent the fura balls from losing moisture and thus cracking over time. If the fura balls are not packaged properly, which is often the case, the coated flour cannot prevent dust contamination and fly infestation on exposure of the product.

The generally agreed method of marketing fura is by hawking the fura balls (25–30 g) in a calabash basin covered with a raffia made tray (matakandi) or a chinaware basin with a cover. At the vending point, the balls of fura are wrapped in a low-density polyethylene bag for the customer or mashed into fermented skim or wholemilk for immediate consumption. Regardless of whether a packaging is large (perhaps for distribution to an industrial consumer) or small (for sale to the end user), packaging has three basic roles [11]. First, to act as a container, enabling the chosen quantity to be handled as a unit without loss during distribution and storage. Secondly, to protect against squashing, breakage and spoilage during distribution and to maintain the food in good condition through a planned shelf-life and lastly, to communicate necessary information about the foodstuff, such as its origin, method of use, weight, quality or destination. Strictly speaking, therefore, fura is distributed with the minimum of packaging. Processors and retailers of fura are primarily

concerned with reducing waste and having a container for their food. Their choice of suitable packaging is to provide protection during a generally short shelf-life and for local distribution. With population growth and consumers of fura migrating to towns and continents some distance from where fura is made, a wider range of fura packaging is required. Such packaging must be able to withstand transportation hazards, provide longer shelf-life and communicate necessary information about the product.

It takes about 1 to 5 h for 34% of the respondents to sell their fura; 58.7% required 1–2 days. The rate of sale of fura actually varies with the weather; peak demand for fura is during the hot season (March to June) when the temperature range is 24.7°C to 42°C.

Storage stability of fura

Leftover fura can either be preserved by refrigeration, sun-drying or at ambient temperature (Table 4). Storage at room temperature was the most common method of storing leftover fura. Choice of ambient temperature is not surprizing since a majority of the processor/retailers do not have access to refrigerators. Storage at ambient temperature is achieved by coating the fura balls with more flour (if available) and leaving it in a desired container (plate or calabash) uncovered. Storage of fura uncovered exposes the product to insects, flies, and dust. The presence of dirt and dust on any food will increase the rate of spoilage, because they carry microorganisms [11]. Unfortunately, the fura is not heated before consumption. This habit constitutes a health hazard. The shelf-life of fura stored under these conditions was indicated by 40.5% of the respondents as 1 day (24 h), 26.7% of the respondents as 2 days and 3 to 4 days by 23.2% of the persons answering the questionnaire. The variation in shelf-life depends on the ambient temperature. It is known that shelf-life increases with decrease in temperature.

Sun-drying of fura is normally achieved by breaking up the balls in a tray or any flat container and keeping it under the sun uncovered. No effort is made to protect the food from dust and flies while under the sun. Sun-dried fura is rehydrated in fermented whole milk (kindrimo), fermented skim milk (nono) or water; sugar may be added. There is no reheating of the food and this may present a health hazard as the sun-dried food may have been contaminated by dust. The respondents found it difficult to estimate the shelf-life of sun-dried fura. It is more reasonable to think that being a dried product with low moisture content, its shelf-life can be as long as 2 to 3 weeks. However, all the respondents indicated that the texture of sun-dried fura is not very desirable compared with the fresh product. According to 11% of the respondents, refrigeration of fura gives a shelf-life of 7 days. This is quite erroneous. Researchers have found that fura at refrigeration temperature (5°C)

Table 4. Storage stability of fura[a]

Question	Status: Processor/ Retailer n = 274	Processor/ Consumer n = 171	Total n = 445	*p*-value
(a) Storage conditions				0.56
Refrigeration	60 (21.9)	34 (19.9)	94 (21.1)	
Sun-drying	54 (19.7)	69 (40.4)	123 (27.6)	
Ambient	151 (55.1)	58 (33.9)	209 (47.0)	
(b) How long does fura keep under the following conditions				0.14
Refrigeration				
7 days	36 (13.1)	13 (7.6)	49 (11.0)	
Sun-drying				
2 days	13 (4.7)	0 (0)	13 (2.9)	
2–3 weeks	19 (6.9)	0 (0)	19 (4.8)	
Ambient				
1 day	114 (41.6)	66 (38.6)	180 (40.5)	
2 days	93 (33.9)	26 (15.2)	119 (26.7)	
3–4 days	63 (23.0)	40 (23.4)	103 (23.2)	
(c) Best storage condition to prolong shelf-life				0.16
Refrigeration	154 (55.8)	74 (43.3)	228 (51.2)	
Sun-drying	46 (16.8)	62 (36.2)	108 (24.3)	
Ambient	59 (21.5)	25 (14.6)	84 (18.9)	
(d) Sign of spoilage in fura				0.14
Off odor	143 (52.2)	52 (30.4)	195 (43.8)	
Crack	29 (10.6)	9 (5.3)	38 (8.5)	
Mold	66 (24.1)	87 (50.9)	153 (34.4)	
Sticky	29 (10.6)	18 (10.5)	47 (10.6)	
(e) Number of days after which not safe for consumption				0.37
1 day	0 (0)	49 (28.6)	49 (11.0)	
2–3 days	122 (44.5)	74 (43.3)	196 (44.1)	
4–7 days	143 (52.2)	37 (21.6)	180 (40.5)	
(f) Can fura be consumed after the day stated in (e) above?				0.44
Yes	136 (49.6)	106 (62.0)	242 (54.4)	
No	129 (47.1)	53 (31.0)	182 (40.9)	

[a] Figures in parentheses are percentages.
[b] Kruskal–Wallis one-way ANOVA test.

keeps for only 3 days (Jideani et al., unpublished). The best way to preserve fura according to 51.2% of the respondents is at refrigeration temperature. Unfortunately, not many processors and consumers of fura have access to refrigerators.

Some organoleptic spoilage signs of fura are off-odors, surface cracking, visible mold growth and sticky texture. The two major signs are off-odor and mold as indicated by 43.8% and 34.4% of the respondents, respectively. A majority (44.1%) of the respondents indicated that fura stored at ambient temperature is not safe for food after 2 to 3 days. In practice, some consumers wash off the mold and slime on the surface of the fura balls and consume the product as normally. Hence, in their own words 'fura does not spoil'.

It is strongly believed that if fura production is improved, consumers can have confidence in the product and better prices can be obtained by the producers. Moreover, with the increasing influence of advertising upon customers, small food processing enterprises making fura will have to improve the packaging and preservation of their products if they are to survive the competition.

Acknowledgments

The authors are grateful to Mrs Rista Yakubu of Gombe State Agricultural Development Programme, Miss Chinwe Emuwa and others for helping in the distribution of the questionnaires and interviewing of the respondents.

References

1. Jideani VA, Wedzicha BL (1994) Reaction of sorbic acid in millet and sorghum doughs: Reaction with thiols. Food Addit Contam 11: 539–548.
2. Ihekoronye RI, Ngoddy PO (1985) Integrated Food Science and Technology for the Tropics. London: Macmillan Publishers Ltd.
3. Jideani VA, Olakunmi OA, Jideani IA (1995) Shelf-life and predominating microflora of a non-fermented pearl millet dough (fura). Nigerian Food J 13: 83–93.
4. Microsoft Acess (1994) Microsoft Access version 2.0. USA: Microsoft Corporation.
5. SPSS (1993) SPSS for Windows Release 6.0. USA: SPSS Inc.
6. Dziezak JD (1989) Spices. Food Technol 43: 101–116.
7. Giese J (1994) Antimicrobials: Assuring Food Safety. Food Technol 48: 101–109.
8. NRC (1996) Lost Crops of Africa- Grains, Vol 1, National Research Council. Washington, D.C: National Academy Press.
9. Perten, H (1983) Practical experience in processing and use of millet and sorghum in Senegal and Sudan. Cereal Food World 28: 680–683.
10. Huang S (1989) A look at noodles in China. Cereal Food World 41: 199–204.
11. UNIFEM (1993) Packaging. United Nations Development Fund for Women Food Cycle Technology Source Book No. 7. Italy: G.M.G.