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THE FERMENTED FOODS OF AFRICA: THEIR POTENTIAL

by

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I. INTRODUCTION

Bread, cheese, beer, wine and vinegar are fermented food products that have been studied since the days of Louis Pasteur. These products are not part of the new surge of interest in what has come to be known as indigenous or traditional fermented foods, which for all practical purposes began in the aftermath of World War II. The best-studied of these as a group, are those of South East Asia. The preponderance of literature on products such as soy sauce, tempeh, fish sauce and paste, etc., has left the impression in many minds that South East Asia alone went away with the art of food fermentation.

Nonetheless, the literature available to date on the fermented foods of Africa, albeit scanty, seems to indicate the presence in this "cradle of mankind" of numerous and varied kinds of both fermented products and methods of preparation. Very little of the knowledge encompassing these foods has been tapped to this day. The indigenous knowledge concerning these foods is found with elderly rural women. The depth of knowledge these women command cannot be readily appreciated until one actually delves deeply into it. To say the least, these women's knowledge is both amazing and overwhelming - an endless, ever-expanding universe of its own. Again, it is only when one has been subjected to an in-depth exposure to this world of information that the facts about it begin to dawn on one.

The bottom line is we do not know much about the methods of preparation and the extent of the dependence on food fermentation in the cottages of Africa's straggling villages. Time is not on our side; these foods and their methods of preparation must be documented. Urbanization, which has already taken its toll, continues to pose an impending danger on what remains of the indigenous knowledge concerning these foods. The unwritten, down-transfer of know-how from mother to daughter has been breached by urbanization, and knowledge is slipping away into the grave with the passing away of old memories. We need to have "food banks" of knowledge analogous to "gene banks".

Perhaps a word on the gathering of indigenous knowledge itself is in place at the end of this introduction. The securing of detailed and correct information from old rural women is not as easy as it might seem at first; it could be quite a tricky business. There is not much in the literature by way of offering useful guidance. The person gathering the information is largely on his or her own. The first steps are likely to stumble into puddles and potholes, but as experience is gained, things become better controlled. The duration of the time of gathering is perhaps the most important single factor in ensuring as accurate and thorough information as possible. Second to this perhaps, comes the building of the bridges of mutual confidence between the investigator and the source of information - the elderly rural women. Among male investigators, the best ones would be those sensitized towards the cause of women - those who know that women are technologically-minded

too. This type of investigator would go to the villages to learn, not to teach.

As much as possible, information on indigenous foods should be taken from old women. Information taken from men of all ages and from young women should be considered with great caution. A man living forty years with an expert woman in the same house would give extremely erroneous accounts of the food his wife has made for all those years!

The social aspect of information gathering is a complex one. For male investigators, the job might be tougher, perhaps calling for a certain degree of mettle. In Sudan, interest in food aspects of life means meddling into women's affairs - one of the seven shames. Beside the grinning and simpering of others, this author had to put up with the taunts of members of his own extended family who felt shamed.

Rural people tend to remain reticent about certain foods - the foods they know, from past experience, that townfolk (symbolized by the investigator) ridicule and belittle. In one such case, which the author came across, a young girl told of a food which turned out to be an interesting product. The child, however, was flogged by the family for revealing the food!

Finally, however detailed the verbal description of a food preparation method given by an experienced woman, it would not be complete. The investigator is advised to watch the process at work. He or she would more often than not discover some important nuance that was skipped during the verbal description.

2. AFRICA'S FERMENTED FOODS ARE ANCIENT

Africa is believed by many experts to be the home of origin of mankind (Clark, 1976; Lemonick, 1987; Birx, 1988). Should this be true, it would be very likely that the first person to consume a fermented food product lived in Africa. Many regions in the African savannah have been shown to have supported many human communities early in prehistory. Archaeological excavations revealed that human communities lived in the Central Nile Valley at the confluence of the Blue and White Niles some 9,000 years before present (BP) (Arkell, 1949). These people lived mainly on Nile fish and snails as food. Three thousand years later, that community was replaced by cattle-owning people who lived mainly on beef, but also gathered (Krzyzaniak, 1984), or even cultivated (Klichowska, 1984; Doggett, 1988) sorghum and millet.

Similar communities flourished somewhere else in Africa. Linguistic evidence, for instance, has suggested that agriculture had been known 7,000 years BP in Ethiopia and 6,000 BP in the Lake Chad region where Sorghum and millet were used as staples and animals were raised (Ehret, 1984).

It would be hard to believe that the communities discussed above did not know food fermentation. With such perishable foods as meat, fish, milk and moistened flour in a hot, humid environment, such as prevailed in savannah Africa, chances are very high that those people did practice some form of food fermentation. Evidence, however, is lacking.

Nevertheless, we do have concrete evidence that Africans did practice food fermentation in sub-Saharan zones still thousands of years ago. The Central Nile Valley, the Sudan today,

was the seat of the rise and fall of perhaps the best-known ancient kingdoms of sub-Saharan Africa. These included Kerma (2,600 to 1,500 BC), Cush (1,500 to 690 BC) and the Kingdom of Meroe (690 to 325 AD). Of these, we know more about daily life in the latter kingdom, Meroe. The people of that kingdom, which thrived some 2,000 years ago, knew very well the art of fermentation of food and beverage. Perhaps today, nothing epitomizes African fermentations better than sorghum beer. This beer was brewed and consumed by the Meroites. The Greek geographer, Strabo (7 BC), mentioned that the Ethiopians (Meroites) made a drink from sorghum. Shinnie (1967) equated this with the present-day sorghum beer of Sudan called *merissa*. Even more indicative is the impressive wall graffito left for us by the Meroites, which depicts two male figures sitting under a thatch in the act of drinking beer from an earthenware jar placed between them. One of the figures is shown holding a bamboo straw with which he is sipping a drink from the pot. The artist wanted to communicatae to us the fact that the drink was inebriating, which he achieved by drawing lines radiating from the head of the drinker (Hintze, 1979). Exactly the same situation shown by the drawing can be seen today in parts of Sudan and in other African countries, like Uganda.

Wine making was also widely known in Meroe. Wine presses and numerous wine jars have been uncovered by archaeologists (Adams, 1966). In addition, a drawing has been found on a Meroitic ceramic jar showing a procession of dancing men carrying ladles about to be dipped into wine jars (Woolley and Randall-McIver, 1910).

The people who built these kingdoms of Sudan were believed to be black Africans and so were the communities who lived much earlier at the confluence of the two Niles (Arkell, 1949; Shinnie, 1967). In fact, the drawings of men and women from the era of Meroe show clear African features, including frizzy hair and large facial features. These drawings can be found in Dirar (1993) and references therein.

The purpose behind the above discussion is to give the reader the necessary background against which to judge the importance of food fermentation in the life of the African.

3. SOME SELECTED FOODS AND PROCESSES

Our discussion here will be confined largely to examples from the fermented foods of Sudan. In spite of the fact that the dominant culture in Sudan is Arabic and Islamic, about 90 per cent of the 90 or so fermented foods of the country are pure African foods not known in the Middle East. It is this fact that gives legitimacy to the title of this article. More detailed accounts can be found in Dirar (1993) and Dirar (1994).

African fermented foods can be broadly grouped into three functional groups: the staples, the relishes and sauces, and the beverages. In Sudan, the staple dishes are basically made from sorghum and to a lesser degree from pearl millet. These two cereals form the indigenous grains of Africa and people must have known how to process them for thousands of years. The introduction of cassava and corn following the European invasion of the Americas in the fifteenth century resulted in a recession in the use of the indigenous grains in many parts of the continent. Nevertheless, the sorghum-and-millet culture persisted in important regions. Cassava and corn (maize) did not find footing in the Sudan, where the sorghum culture still figures prominantly.

Sorghum fermented products in Sudan form not only the major and most important foods, but the most sophisticated, and the ones prepared through the most complicated procedures. It is noticed that practically all sorghum products of the Sudan are fermented, while those from millet are not necessarily so. Research has shown that fermentation of sorghum raises the digestability of its protein from a value as low as 45 per cent to as high as 86 per cent! (Axtell et al., 1982).

Some 30 important food products are made from sorghum in Sudan. These can be grouped into two: those made from ungerminated grain and those made from sorghum malt. The former are the more important, being the true staples that go with the various relishes and sauces, and the second group form the beverages and snacks.

3.1 Sorghum Products from Ungerminated Grain

Aceda is the traditional stiff porridge of rural Sudan and which makes the staple dish. It is made from sour dough fermented by a spontaneous population of mixed lactic acid bacteria. It is generally consumed together with one of a variety of sauces, but it can also be slurried in water to give *moss*, which is used to fatten women.

Kissra is often described as the staple of Sudan, and although this is not entirely correct, it is still acceptable. *Kissra*, which is a paper-thin sheet of bread made from the same sour dough from which *aceda* is made, is replacing the latter in many parts of Sudan. It is probably more nutritious than *aceda*, as it contains about 50 per cent solid matter, whereas *aceda* has about 20 to 25 per cent. The thin wafer, which is baked by spreading a small portion of a thin batter on a large hotplate, takes only 17 seconds to bake.

Abreh is probably the finest sorghum food by all standards. It comes in smooth, almost transparent flakes of sheet-bread, much thinner than *kissra*. Its batter is obtained by prolonged souring of sorghum flour. It is usually prepared in the holy Muslim month of Ramadan, when people fast all day. It is supposed to serve as a thirst quencher.

Nasha is a sour thin porridge made from sorghum sour dough like that from which *aceda* and *kissra* are made. A quantity of the sour paste is mixed in a copious amount of water. After resting the suspension to settle the coarser particles, the supernatent is decanted and given another period of rest. It is again decanted and the process repeated until virtually no more precipitate is obtained. The liquid is then boiled to give *nasha*, a drink "as smooth as bone-marrow". It is especially given to malaria patients and to Ramadan fasters.

Jiriya is certainly the most refined of all sorghum and millet porridges of Sudan. It is made from a starch preparation called *jir* (literally, lime). The porridge is prepared for dignitaries and always comes with the richest of sauces. It is a translucent, well-moulded mass that shakes like jelly. The procedure followed in the preparation of *jir* is probably the most complicated of all African food preparation methods. The product, *jir*, is related to West Africa's *ogi*, although the starch of the latter is less refined and the procedure followed in its preparation much shorter (Bascom, 1951).

3.2 Sorghum Products from Sprouted Grain

An aspect of special importance of the sorghum food culture is the extensive use of sprouted sorghum grain in Sudan. Commonly in Africa, germinated grains are used for the making of beer. While this is also true for the Sudan, important non-alcoholic foods and beverages are also made in this country. The importance of sprouted grain has taken new proportions in Africa in the last years, primarily in its capacity as a possible candidate for upgrading and developing baby and weaning foods. The initial step in this endeavour should be the documentation of the traditional malt products in Africa. The Sudan has some seven solid food products that are traditionally produced from sorghum or millet, in addition to beer.

Hussuwa, for example, is one such product mostly given as a treat for children. It is mostly in the form of solid balls or mass and could be consumed solid as it is, or slurried in water first. It is also consumed by adults, particularly as an energy-restoring food. The sweet-sour, brown product is often referred to as 'poor man's milk'. Its preparation methods take many forms. For instance, one could watch a woman in the village cook the three meals of the family out on an open fire daily for three months without having a hint that a few inches underneath that fire a large earthenware jar is buried which contains the fermenting *hussuwa* in warm incubation.

Hulu-mur or 'sweet-sour' comes in the form of scorched brownish flakes originally baked on a hotplate in large sheets. This is another of the fermented products prepared especially for Ramadan fasters. Its nutritional function is to replenish the blood sugar level. The flakes, which contain some 30 per cent sugar, are first soaked and the soak-water consumed, while the rubbish is wasted away.

Assaliya is clear beer made from *assal* or syrup obtained through a tedious process of extraction of sorghum or millet malt. The procedure to obtain *assal* is again one of the most complicated in Africa The related African clear beers, such as *otika* of Nigeria (Ogundiwin, 1977), *amgba* of Cameroon (Chevassus-Agnes et al., 1976), *chakpalo* of Benin (Mathurin, 1985) and *dolo* of Mali and Burkina Faso (Rooney et al., 1986) are prepared by simpler procedures. The *assal* (Arabic for honey) from which *assaliya* is made is sometimes given fresh to babies.

Khemiss-tweira is composed of five ingredients: grain flour, malt flour, roasted sesame seeds, salt and sugar. The food comes in the form of a granular meal. In its making, it comes through two stages of fermentation. *Khemiss tweira* is basically a traveller's food. It is consumed by adding water to the dry meal to a paste or a slurry. It is also given to school children staying in boarding houses away from home. The product is probably a nutritionally balanced meal.

3.4 Fermented Sauce Ingredients

3.4.1. Meat Products

Some eleven fermented meat products are made in the Sudan. The most important is, a member of the jerky types. Strips of meat are either sun-dried or shade-dried to give the product. The other fermented meat products are a bit unorthodox. In *beirta*, for instance, the kidneys, spleen, liver, lungs, heart and caul fat are chopped and mixed with 2 kgs. of chopped hind-quarter muscle meat and placed in a pot. Then about half a litre of milk is

added and the whole hodge-podge is allowed to undergo fermentation for four days. Now, the pot is opened and a little salt mixed in and a second stretch of fermentation is allowed for three days. The product is used to make sauce for *aceda* porridge.

Miriss is prepared by fermentaiton of the caul fat, i.e. the fat surrounding the stomach. The fat is kneaded with a quantity of an ash preparation, *combu*, and fermented for up to six days. The product is very white and extremely foul-smelling.

At least three fermented products are made from fresh bones (and their attendant meat scrapings). *Dodery*, for example, is prepared from the marrow-impregnated, meshy joint bone endings. These are chopped, sun-dried and pounded into a paste which is mixed with *combu* and fermented for up to five days.

3.4.2. Fish Products

The Nile Valley probably has a greater variety of fermented fish products than other regions of Africa. The Sudan has at least four distinct such products. *Kejeik* represents the common, dry, split fish of Africa. *Fesseikh* is fermented whole fish made of a particular species and is known also in Egypt. However, *mindeshi*, a fish paste, and *terkin*, a fish sauce paste, appear not to be known in other parts of Africa.

Basing his judgement on indigenous knowledge only, Dirar (1993) wrote that "*terkin* seems to carry a tag of antiquity". Actual archaeological excavations supported this statement. Ahmed (1992) uncovered earthenware jars in northern Sudan in which he found fish bones which he identified as remains of *terkin* perhaps 3,000 years old (Ahmed, personal communication).

3.4.3. Dairy Products

The most important product here is *rob*, or buttermilk. Milk is soured overnight, churned to recover the butter and what is left is *rob*. It can be drunk as it is, turned into sauce for *aceda*, or wasted away as a by-product of butter production. Butter is boiled to give the highly valued *samin* or ghee.

Gariss is fermented camels' milk and is famous for having alcohol in it. It is basically the food of camelherds, i.e., young men who spend months out with the camels away from home. *Gariss* is claimed to have medicinal value. It is consumed whole without churning.

Biruni is interesting because it may be fermented and aged for up to ten years. It is mainly a food security product. At the time of milk abundance, villagers take surplus milk to the medicine man who keeps these milks fermented for years and other people may help themselves with this milk stock at times of dearth.

3.4.4. Plant Products

The most important of these are meat substitutes and flavours. The fermentation takes a proteolytic course, giving a foul-smelling product. the flavour of which simulates, after cooking, that of fermented meat.

Kawal is made from the green leaves of a wild legume shrub, *Cassia obtusifolia*. The leaves are pounded, packed in a clay pot, which is then buried in a pit in the ground for two weeks. The fermented paste is then moulded in the form of small balls or discs and sun-dried.

Furundu is made from the pounded seeds of the minor cultivated crop *Hibiscus sabdariffa*, or roselle. The paste made from the crushed seeds is mixed with *combu* before fermenting. The sun-dried fermented balls smell typically of slightly fermented meat products.

Sigda is made in a similar way as for *furundu*, but sesame seeds are used instead. The product is much richer in oil and may come as a soft paste or in the form of balls.

3.4.5. Unconventional Products

These are made from raw materials that do not enter into the mainstream of what is normally considered food. In a way, these products are bizarre products and no similar products have been reported in the literature.

Okah is cows' urine fermented in large earthenware pots for at least one year and may reach an age of ten years. The urine must come from a heifer that is no longer suckling, but which has not yet reached adulthood, and it must be feeding, at the time of urine collection, on green pasture. The product, which becomes thick in the course of time, is highly esteemed and is used to prepare sauce for *aceda* porridge. It is claimed to be a cure for malaria.

Beiga is fermented caterpillars of a special kind recognized by the tree on which they feed. Live larvae are gathered in large numbers and placed live in a pot, which is covered for six days. During this period the caterpillars die and undergo fermentation. The mass of separate insects is sun-dried and used for sauce making as required.

Duga is fermented locusts. Big, fat, egg-laden insects are placed in a pot and allowed to ferment for three to ten days. They are then sun-dried, pounded into a meal and kept in cloth bags for use in sauces.

Kesherneh is obtained by the fermentation of a certain kind of a jumping frog. The frogs are first boiled in water, sun-dried, pounded and fermented. The product may be sun-dried in the form of small balls.

4. ROLE OF AFRICA'S FERMENTED FOODS IN NUTRITION

The fermented foods of Africa have been developed in a hostile environment of food shortage, hunger, famine and drought. The fact that they prevail in abundance in the savannah and semi desert zone of the continent attests to this and so does the fact that they are mostly prepared in the seasons of plenty and kept for the seasons of little. The fermentation and sun-drying as a double preservation method of such material as hides, skins, hooves, entrails, fat, insects, leaves, etc., all come in the context of food security.

While the evidence indicates that in savannah and semi-desert regions of the continent,

calorie deficiency is the primary concern of man and animal (Guthrie, 1983), the need for protein follows closely behind. The deficiency in energy is made up by fermenting fat and malt-containing cereal products which have an abundance of sugar.

Protein shortage is tackled in a variety of ways. First, every part of the slaughtered animal that can be consumed is fermented, sun-dried and stored. Secondly, insects and other small animals which abound in the rainy season are collected, fermented, sun-dried and stored. Thirdly, plant protein sources are tapped and proteinacious parts such as leaves and seeds are fermented, sun-dried and kept for later use.

But the major source of dietary protein in the sorghum-millet regions of Africa is the cereal itself, the staple. The more porridge one consumes, the more protein one gets. The fermented foods are mainly relish and sauce ingredients and they encourage the intake of more of the cereal.

It is not only the quantity of protein taken up that matters, but the quality of the protein itself. Experts believe that in Africa the most limiting amino acids are the sulphur containing amino acids, although lysine is often quoted as the limiting one (Platt, 1964; Annegers, 1974). It is interesting that the three major meat substitutes of plant origin in Sudan, *kawal*, *furundu* and *sigda*, were found to be particularly rich in sulphur amino acids (Harper and Collins, 1992). *Kawal* is additionally rich in calcium and iron. The meat substitutes of plant origin make an important group of fermented foods in Africa and prevail across the continent from the Nile to West Africa. Those of West Africa perhaps include *dawadawa*, *ugba*, *ogiri* and *ogili-isi* (Ochinfa, 1986; Odunfa and Oyeyiola, 1985; Achinewhu, 1983; Raymond, 1961).

A major group of nutrients that the fermented foods furnish is the vitamin group. The provision of B vitamins by African beers, for instance, is well-documented (Platt, 1964; Chevassus-Agnes et al., 1976). The meat substitutes of plant origin have not been well-studied for their vitamin content, but it is highly likely that they are rich in this group of health-promoting nutrients. The frequent involvement of fermented foods in tribal religious rituals and the hal- of sacredness that is sometimes attached to certain fermented foods seem to point towards their content of vitamins and amino acids. The symptoms of vitamin deficiency diseases are so strange that the rural African would easily refer their cause to higher powers and the foods that cure such deseases may well be considered sacred.

Fermented foods may help protect the consumers against disease by providing minute doses of antibiotics produced by the microorganisms effecting the fermentation. Al-Tunisi (1850) inquired about the reasons the foods of the people of Darfur, Sudan, were either sour or rotten and the inhabitants of the province told him that he who did not eat those foods would have to fear disease. Hesseltine and Wang (1980) mentioned that fermented foods of the orient contained antimicrobial substances that might give protection against infection to people consuming them.

5. INDUSTRIALIZATION OF AFRICA'S FERMENTED FOODS

5.1 Strategy

Obviously there is a political aspect to the industrialization of Africa's foods. A number of questions will have to be answered first; a number of issues have to be resolved. Who would be the targeted consumer of the industrialized product? Who should collect the financial benefits? Who should own the industry? Where does the intellectual right lie? What level of technology should be applied? Which food should be given priority in industrialization?

The indigenous fermented foods of Africa have been developed and the technology of their production preserved through the millenia by poor rural women. These women depended on these foods to feed their families in a world of scanty provisions. Many of them sell these foods in the local markets as an income-generating activity which helps supply medicine and send children to school. Large scale production of these foods would certainly put these women out of business and the damage incurred on their families, unless somehow checked, would be enormous.

5.2 Implementation

Documentation of the fermented foods of a country should be a good point to start an industrialization programme. The gathering of detailed indigenous knowledge of various African countries about their foods and the dissemination of this knowledge across the continent and the resulting exchange of indigenous ideas and techniques should in itself help in the development of these foods. A good example is the special interest given by African scientists to the Sudanese sorghum product *abreh*. Researchers in West Africa are contemplating the idea of producing *gari* in the form of *abreh* flakes. In southern Africa, in Botswana in particular, researchers who are interested in non-alcoholic sour sorghum products, are thinking of producing the Sudanese product *abreh* in that part of the country. It is interesting to note that these researchers did not become interested in *abreh* because they read about it, but because they saw and touched samples of the product. International agencies who are interested in African fermented foods may need to try holding a collector's exhibition of these foods in place of the usual traditional conferences.

African food fermentations are rural women's biotechnology. These rural women actually deal with microbial starter cultures and with enzyme preparations. In one salient example in Sudan, women use a special starter culture for making a honey wine, *duma*. This is a lucrative business in the towns of the southern Sudan. Each woman has her own starter strain or line, which she keeps as a secret not to be given to others. The starter strains consist of yeasts and bacteria in the form of tiny pellets called '*duma* grains'. Women have developed full knowledge of how to isolate this starter culture from nature through enrichment culture techniques, how to build up a large microbial biomass amounting to litres in size, how to use this biomass to produce the mead in a matter of hours and how to preserve the culture live for years.

Berbassa is a microbial culture used in the far north of the country to prepare a special kind of bread, *gergosh*. Again, an enrichment culture technique is followed. Milk is over-boiled and evaporated to a condensed state. A few legume beans are then thrown into it while it is still warm. The container is well closed and buried in a stack of grain for warmth. Within 24 hours a frothy preparation is obtained which constitutes the starter culture.

The most common enzyme preparation used in Sudan is sorghum malt. In the brewing of the popular opaque beer, *merissa*, only 5 per cent of sorghum malt is used. All evidence shows that this small amount of malt is used as an enzyme preparation. When for some reason this enzyme source is not wanted, women use barley and wheat enzyme sources (or ungerminated grain) to convert sorghum starch to sugars. They know that unsprouted sorghum grain has no amylase enzymes, whereas barley and wheat have. The technique is used up north, where the last two cereals are grown.

Microorganisms make the difference between the fermented food and the starting raw material. It is therefore imperative that research identifies the species used in a certain process and paves the way for the formulation of a starter culture for it. Selection of more effective strains would in itself raise the quality of the food. Later improvement of these strains through the conventional genetic techniques should lead to even better starter cultures. Theoretically, genetically engineered starter strains could be developed for specific situations, although this should not be an urgent matter. The genetics of microorganisms used in indigenous fermented foods will form a chapter in the second edition of the *Handbook of Indigenous Fermented Foods* (Steinkraus, personal communication).

Research should be carried out on the nutritional aspect of the food to be industrialized. Each food bridges a gap in the nutritional system. The role of the food in providing essential amino acids, vitamins and minerals should be well understood before committing the product to industrialization.

Admittedly, some cottage procedures of food preparation are tedious and time-consuming, since a great number of steps are involved. Technologists and food engineers tend to reduce this number of steps. It is understandable that sometimes economic considerations force us to do this, but if the deletion of a certain step in the process would be at the expense of the nutritive value or acceptability of the food, then industrialization has defeated its purpose. All the more often this situation happens when technological development outdistances research. Also, the phrase that "this step is superfluous" is often encountered in the literature of African foods. It is a fallacy that the African rural woman has any time to waste on a "superfluous step" in food preparation. The step might not be dispensable, but perhaps we have not discovered its essentiality. Therefore, no part of the indigenous procedure followed in food preparation should be omitted until its merits have been disproven.

A few of the indigenous fermented foods of Africa have already been industrialized (Steinkraus, 1989). The South African approach to the large-scale production of sorghum beer and of the sour pap *mahewu* is one of industrial affluence with facilities identical to any Western food production facility. This approach might not be suitable for most African countries, taking into consideration the rather austere economic conditions.

The Nigerian approach to the industrialization of *gari* and *ogi* has a greater degree of economization and dependence on local expertise and material in building the plants and equipment. There is much simplification here and the whole business looks like it could suit a number of other African countries.

In Sudan, *kissra* and *abreh*, the sorghum sheet-breads, have been produced industrially.

The production line which can be packed all on one truck has been invented by a non-specialist. The whole plant has been manufactured almost completely in Sudan and its use is spreading widely in the country. However, unlike the case of South Africa and Nigeria, this development in Sudan has not been backed by research. The whole thing is rather impirical, and microbial spoilage of the batter has often led to the wasting away of tons and tons of dough. There are some attempts from the side of some international agencies to spread the use of the machine to other sheet-bread producing countries like Ethiopia and India. *Kissra*, which is taking over rapidly from the porridge *aceda* in Sudan, has a great potential, if given the chance, to replace stiff porridges such as *ugali*, *ting*, *bogobe*, *to*, *dalaki*, *kenkey* and *tuo zaafi* of other African countries (Steinkraus, 1983; Campbell-Platt, 1987; Quin, 1964; Vogel and Graham, 1979).

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