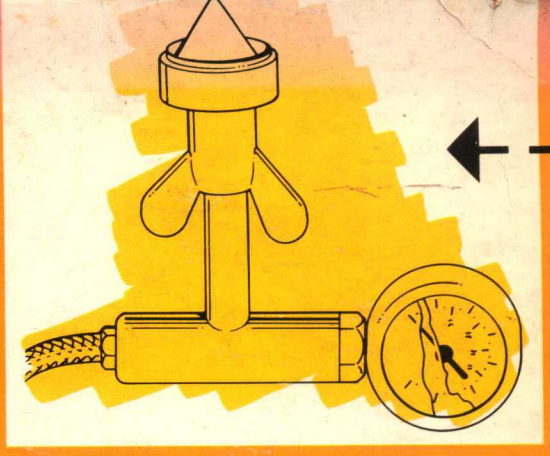

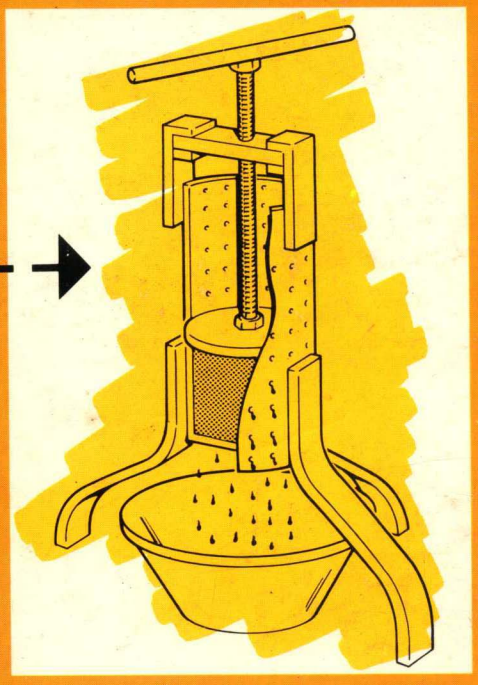

Processing and Preservation of Tropical and Subtropical Foods

J. Maud Kordylas

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J. Maud Kordylas BS MS LFIBA AAABI

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Processing and Preservation
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To the glory of God, and the memory of my sister Charity

Preface

Agricultural production in Africa is in the hands of small-scale peasant farmers who produce over 80 per cent of the staple foods and 50 to 60 per cent of the raw material needed by industry. Small farms are scattered right across the African continent, and small-scale traditional food processing and preservation units are synchronized with the farming system. Together, the two provide the bulk of food products needed to feed 75 to 80 per cent of the population — those living in rural areas as well as workers living in the towns and cities.

When African nations attained their independence, they were anxious to accelerate the industrialization of the food sector. As a result, the existing and familiar food production systems were ignored and left to stagnate and deteriorate. African countries opted for the importation of large-scale food processing units under a policy of import substitution. This choice was extremely costly to them and has led to some complex limitations on development. Today, they depend very heavily on the countries exporting the food processing technology for maintenance and spare parts. In certain cases, the raw materials and other inputs needed to keep the plants going also come from abroad. Since their commissioning, most of these plants have never operated at full capacity, because of their size and the large quantities of raw materials needed to feed them (which cannot be supplied through the traditional farming system). In Ghana, for example, the majority of plants operate at 4.2 to 60 per cent capacity, with an overall average productivity of about 35 per cent.

There has been very little opportunity to use local unskilled labour to run the larger modern plants because they are highly automated. And the new processes and techniques have not been widely taken up because, in most Africa countries, they are not fully linked into the present level of technicological development. At best, they have succeeded as a highly sophisticated but illusory form of industrial growth superimposed upon a largely under-developed base with very little infrastructural support from within to sustain them. Their continuous functioning is supported at a very high cost, while their physical transplantation does not bring about any genuine development to the majority of people. At worst, they are gradually grinding to a halt for lack of spare parts, raw materials, and proper management.

African governments are becoming very concerned about the disproportionately large amounts of foreign exchange spent in supporting such industries which, in the main, only provide products for the urban populations. In most African countries, these account for 20 to 25 per cent of the total population. As a result of this unhealthy inbalance, governments are looking seriously at alternative types of industrial development, particularly in the food sector, to involve the nutritional welfare of the majority of people.

Interest is now being focussed on what Africans have which they can use as a basis for the development of the food processing sector. Research institutions are being encouraged to provide the required data which would enable Africans to improve their local food production, manufacturing processes, and preservation methods.

This book has been written to provide information on tropical food crops: their proper harvesting, handling, storage, processing, and preservation. Emphasis is laid on traditional processes that are available in the tropics, and their importance and relevance to the development of the food sector. Wherever possible, the improvements needed are also stressed. Modern domestic methods have been

elaborated as a means of teaching the basic principles and skills involved in food processing and preservation, in order to help people master skills and gain relevant experience in handling the appropriate equipment. Such knowledge is deemed necessary as a transitional stage to industrial food processing. Although space does not permit a detailed handling of most of the industrial processes available, relevant industrial information has been provided whenever possible.

The contents are organized to give a systematic and formal approach to the study of tropical food crops according to their food groups. While the traditional processes and technologies used in their preservation are fully documented, an attempt has also been made to give the scientific basis to modern techniques which are applicable to their processing and preservation. Teachers can use the book to help students and pupils identify the characteristics of tropical food crops and to adopt a scientific approach in even, between harvest and consumption. Those employed in the food processing industry at the small-scale will find this book useful in organizing and modernizing their production methods and cutting down on wastage. Food scientists may be stimulated to follow up leads for more research and the development of new products and processing techniques. The prospects for industrial development are discussed at the end of each section dealing with a particular food group, and is hoped that this information will stimulate entrepreneurship in the food industry.

The book provides a summary of the existing information on food processing for the tropics with particular reference to Africa. Research was carried out in university libraries using books and relevant conference reports from Africa, Asia, South America, India and elsewhere. Other publications were obtained from international development agencies, such as the International Development Research Centre (IDRC), Canada; the National Academy of Sciences (NAS), USA; the United Nations University; the German Agency for Technical Cooperation (GATE); the Food and Agricultural Organization (FAO); Volunteers in Technical Assistance (VITA); and the publishing departments of *Appropriate Technology*, *International Agricultural Development*, and *Organic Garden*.

Visits were made to markets in Kenya, Tanzania, the Philippines, Togo, Benin, Côte d'Ivoire, Senegal, Nigeria, Cameroon, and Ghana to observe the types of food crops obtaining there and the processing methods used for their conservation. Utensils, gadgets and other equipment used in traditional food processing were also observed and photographed whenever possible. Primary interviews were carried out with those involved in traditional food processing, as well as with those working in small, medium and large-scale industrial food processing in Ghana, Nigeria and elsewhere.

The information gathered was organized to produce this book, which is intended as a reference book for the food processing industry, including food technologist and research scientists, those in teacher training, and in schools and colleges in general. It will not only be useful in Africa but throughout the tropical world.

J. Maud Kordylas
Douala, Cameroon
February 1988

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My sincere thanks go also to Mr Kofi Odoteye, Librarian at IDEP (United Nations), Dakar, Senegal, for sending me numerous relevant publications and articles and for getting me in touch with various organizations in Dakar. His wife, Mrs Augusta Odoteye is acknowledged for collecting and assembling traditional processing equipment for me to photograph. I am grateful to Mr and Mrs Tchetgen who provided me with information on the processing techniques used in Cameroon and also for their moral support. I wish to acknowledge VITA for giving me permission to use extracts from their *Village Technology Handbook* for Appendix 1 of this book.

Special thanks are due to the numerous people in the industrial food processing sector who granted me interviews, especially Dr. J.K. Ladipo of Lisabi Mills, Nigeria, who gave me a guided tour of his factory and allowed me to take pictures. Special mention is also made of the numerous ordinary men and women who readily co-operated with me and provided information at the various markets I visited. Sincere gratitude also goes to Miss Stella Dzandza for her secretarial help including her meticulous typing of the manuscript.

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1 Introduction

1.1 Staple food groups of tropical Africa

The major staple foods of the tropical regions of Africa are classified under six main groups:

(I) cereals,
(II) Root crops, tubers and plantains,
(III) Grains, legumes and nuts,
(IV) Oil seeds,
(V) Fruit, vegetables and sugarcane, and
(VI) Animal protein foods: Meat, game and wildlife, fish and poultry.

Food crops and foods that are of considerable importance under these groups are the following:

Group I Cereals

Maize (Corn)
Sorghum (Guinea corn)
Millet
Rice

Group II Root crops, tubers and plantains

Cassava
Cocoyam (Taro)
Sweet potatoes
Yam
Plantain

Group III Grain legumes and nuts

Cowpea
Bambara groundnut
Groundnut (peanut)
Lima bean
Pigeon pea
Kidney bean
Chick pea
Lentil
String bean
Mung bean
Tiger nut
Cashew nut
Kola nut

Group IV Oil seeds

Coconut (Copra)
Palm nut, Palm kernel
Melon seed (Agushie, Neri)
Groundnut
Shea nut
Cotton seed
Sunflower seed
Sesame seed
Kapok seed
Cocoa

Group V Fruits, Vegetables and sugarcane

Citrus (Orange, Grape fruit, Tangerine, Lemon, Lime)
Pineapple
Banana
Paw-paw (Papaya)
Mango
Sour sop
Sweet apple
Avocado pear
Guava
Sapodilla
Leafy greene
Tomato
Okro or Okra
Pepper
Garden egg (Aubergine)
Onion
Sugarcane

Group VI Animal Protein Foods

Flesh foods
Meat
Beef
Mutton
Goat meat
Pork

Poultry
Chicken
Guinea fowl
Duck
Goose
Turkey

Milk
Eggs

Game and wildlife
Grasscutter
Antelope
Snail
Rabbit
Insects

Fish
Marine and Freshwater fish
Shrimp
Lobster
Prawn
Oyster
Mussel

1.2 Why learn about the food groups in Africa?

It is important to know about crops belonging to each of the food groups, what they can be used for, and what can be done with them both at the domestic and at the industrial level. It is through knowing about these foods that we develop uses for them, and eventually may use them as a basis for the establishment of food industries in the region.

The basic foods of tropical Africa are generally grown by small farmers. They till one to two acres of land using hoe and cutless and depend mainly on rainfall for the crops to grow. Farmers toil throughout the planting season to grow crops. Depending on where they live, they grow a bit of one crop and a little of another, or a whole host of mixed crops. If the crops happen to be cereal grains, they are left in the fields to dry when mature. If harvested cereals are stored while still fresh, they go mouldy and rot because of their high moisture or water content. If the crops happen to be fruit or vegetables, they are harvested as soon as they mature and sold as quickly as possible. What is not sold goes rotten and is wasted.

However, when cereals are left to dry in the field, the grain may be attacked by moulds, insects, rodents (rats and mice), birds and other pests. Likewise, root crops and tubers not quickly used go bad and are discarded. Due to such problems, farmers lose a lot of the food crops they toil so hard to produce. This means less food for the family, if the food crops are grown for food; and less money, if the foods are grown for the market.

If cereal grains are attacked by insects, they eat the best part of the grain which contains the important nutrients or food materials, such as vitamins and minerals needed by the family to keep members healthy and free from illness. The family members do not get the nutrients the need if the grain has been half eaten by insects. If the grain or other food is attacked by moulds, it does not taste good and fresh but mouldy and bad.

To prevent or cut down on such losses in harvested cereal grains and other food crops, it is important to learn what they consist of; how to take care of matured grains or food crops at harvesting time; how to dry, protect, store and preserve them; and how to process foods and food crops into various products to preserve the food materials contained within them. Each of the food groups is dealt with in this book. Wherever possible, individual crops belonging to the food groups are also dealt with.

1.3 Scope of the book

The book deals in detail with each of the six food groups listed above. General information is given on each group followed by a description and the uses of the individual members of the group. Harvesting, handling, storage and preservation methods applied both traditionally and industrially are discussed. Whenever possible unacceptable traditional practices are pointed out and improved methods suggested. The traditional methods of processing which are used for turning the food crops into various products are also dealt with. Attempts are made to give the scientific basis of reactions that take place during the processing of these foods.

The application of appropriate methods using dehydration, fermentation, chemicals, canning, and combinations of these in food processing and preservation are also dealt with comprehensively. Both the domestic, small scale and larger scale industrial uses of such methods for food preparation and the commercial production of food products are also handled. Discussion on each food group concludes with a consideration of the industrial prospects for the commercial development of products that can be made from foods within the group.

Attention is also given to the essential role played by water in most aspects of food processing and qualities as a purification agent are dealt with in detail. The book ends with a chapter on quality control. The definition of food quality is given, food standard laws, standardization, hygiene requirements, packaging and the sensory evaluation of food are all dealt with in this chapter.

Three appendices are included. These are: Appendix 1, which gives directions for the construction of a few simple items of equipment which are useful in food processing and preservation; Appendix 2, which is devoted to units of measurement and conversion tables; and Appendix 3, which provides a list of equipment suppliers and their addresses.

2 The cereal group

The most important members forming the cereal group in tropical Africa are: maize (corn), sorghum (guinea corn), rice and millet. They are cereal grains with similar grain characteristics.

2.1 The seed grain

Maize, sorghum, rice and millet are grains which belong to the cereal group. Although they look quite different from one another and are of different shapes, sizes and colours, they have the same make up. The cereal seed grain or kernel is covered by a hard *seed coat* to protect the grain from attack by insects (Fig 2.1). This protection is quite effective if there are no cracks on the surface. The seed coat surrounds the *endosperm* and the *Embryo*. The *endosperm* is the main part of the kernel which contains a large part of the food material — starch and a bit of protein. That is the part which generally makes food grains important as food for both humans and animals. It provides food for the developing seed if it is planted, and food for the seed during storage. The *Embryo* contains the life of the seed, and it is the part that develops into a new plant when the seed is planted. It contains most of the proteins present in the seed with some fat, vitamins and minerals. The part of the seed coat covering over the embryo is very thin and thus allows the embryo to be easily attacked by insects and moulds. Seed grains that have been attacked in this way do not grow into strong plants, or may not grow at all. It is important, therefore, that all cereal grain seeds used for planting are well protected in a strong sack, and placed in a cool dry place to prevent them from any attack. Cereal grains must be completely dry if they are to store well.

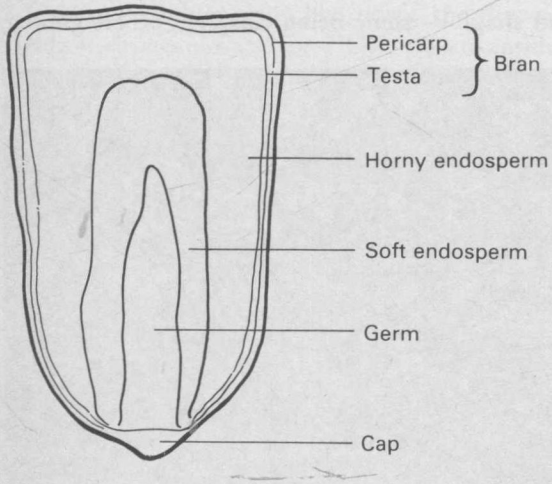

Fig 2.1 Maize kernel in cross-section

2.2 General description of cereal group members

2.2.1 *Maize*

Maize or corn as it is also known, is the most important cereal grain in tropical Africa (see Fig 2.2). Its cultivation is limited by climate. It flourishes under the most varied conditions. There are hundreds of varieties which are adapted to different regions. There are five main varieties, namely: 'Dent', 'Flint', 'Sweet', 'Flour', and 'Popcorn'. The first two varieties, dent and flint, are important as staple human foodstuffs. Flint corn has a hard kernel, while dent has a softer kernel and a larger proportion of soft flour endosperm. Its name is derived from the deep longitudinal grove in the broad end of the grain.

Both of these varieties may be yellow or white.

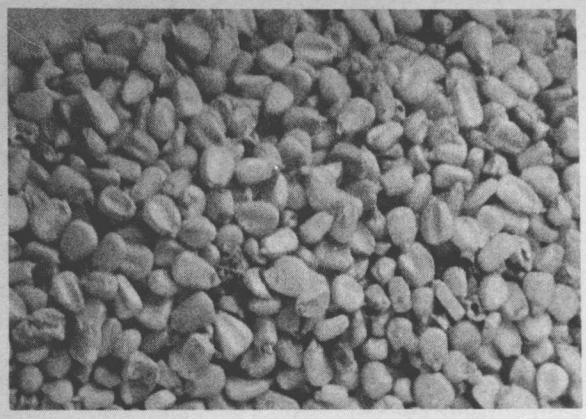

Fig 2.2 Maize

In most parts of Africa, the white variety is preferred and this is mainly grown. Varieties of maize also occur in other colours: red, blue, black, and other mixtures of colours. These are however, rarely produced.

Maize is a large grain cereal. Its kernel, like that of other cereal grains, includes 1) the bran, 2) the endosperm and 3) the germ. The bran, the outermost layer of the grain, is tough and fibrous and acts as a protective cover which holds the grain together. The bran includes the pericarp, which is part of the wall cover: the testa, the hard outer covering; and the tip cap, a small cap which covers the tip of the grain and protects the embryo. The bran makes up about 5 to 6 per cent of the total weight of the grain kernel.

The endosperm forms the main bulk of the maize grain and makes up about 80 to 84 per cent of the kernel. It contains on its surface a layer known as the aleurone layer, which is about one cell deep and is very rich in protein and fat. Underneath the aleurone layer is the horny endosperm, which is translucent, hard and flinty. The interior is filled with the floury endosperm which is more starchy.

The germ or the embryo is located at the lower end of the grain where it is attached to the cob. It is normally large, and about 9.5 to 12 per cent of the whole grain. Different parts of the maize kernel contain different nutrients in various quantities. The endosperm which constitutes about 80 per cent of the grain, contains over 80 per cent of the starch. It contains 75 per cent or more of the grain protein. The outermost portion containing the aleurone cells is the richest fraction of the grain. This contains about 20 per cent protein, equal to, or even more than that contained in the germ. The germ accounts for about 10 per cent of the grain, and contains nearly all the oil and most of the vitamins and minerals.

2.2.2 *Sorghum or guinea-corn*

Sorghum, also known as guinea-corn, is grown extensively in tropical Africa (see Fig 2.3). It is a coarse grass and varies in height from less than a metre to about three metres. There are several wild varieties of the grain on the continent but a lot of varities have also been cultivated. There are types known as 'Egyptian corn', 'White durra', 'Shallu', 'Milo maize', 'Kaliang' and others known as 'Kafir corn' which are white grained and are best for eating. Their stalks are similar to those of maize, with diameters exceeding 2.5 cm in some grain and forage sorghums. The stalks and midribs of some varieties are juicy and contain a sweet juice like sugarcane, and sugar is obtained from them after crushing. Other stalks are dry and pithy and used for fodder.

Sorghum leaves are smooth and their surface waxy which prevents water loss. The head is a loose-to-dense panicle that may carry about 2,000 grains. The size, pigmentation, and other characteristics of the grains vary widely among varieties. The fruit may be erect, close, short and compact; or large, loose and open, with various stages in between. The colour of the grains varies from white, yellow and orange to red and brown. Their size and shape may be large, small, rounded or flattened. The husk differs in size, colour, texture and shape — some being clasping, others gaping,

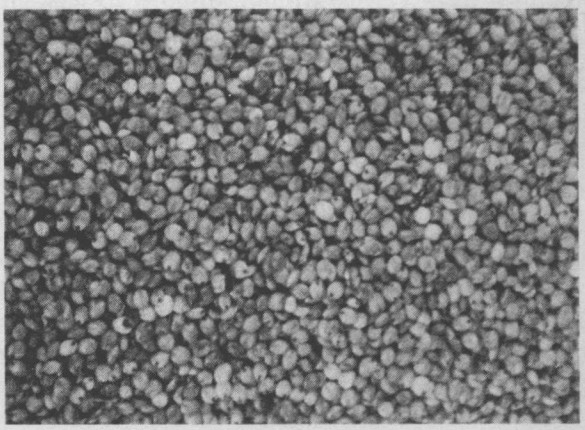

Fig 2.3 Sorghum

and others again persistent or permanent. The kernels are about 4 mm long, and 3.5 mm thick, and vary from 8 to 50 mg in weight with an average of 28 mg. They may be soft or hard, and may give a white flour which is used for food, or a dark, unattractive flour.

The sorghum kernel is divided into pericarp, aleurone layer and testa, which constitutes the bran. The inner part is the endosperm, this is composed of the aleurone layer, the peripheral endosperm area, and the floury and corneous endosperm areas. The peripheral endosperm contains: the small starch granules which are encased in a dense, impervious, protein containing matrix. Proportions of kernel constituents may vary from one sorghum to another.

White grains are preferred to red grains because they give a more acceptable flour. The red-seeded, or dark brown grains, usually have high tannin content and are used for feeding horses. Sometimes a poisonous glucoside compound known as 'dhurian', is found in plants affected by drought in certain sorghum varieties. The compound is toxic to both human and animals, especially when used in the raw form. Preliminary boiling of the grains destroys it. However, it is dangerous to feed the leaves and stems of poor sorghum plants to young animals as the toxic compound may be present in them. Tiller shoots, or growths that appear at the base of the stem after harvesting, are also highly poisonous, and must not be used for animal fodder. The poison is present from germination, it increases to a maximum, and then disappears as the grain develops. Plants at the latter stages are therefore safe to use as fodder. After hydrolysis, the glucoside yields hydrocyanic acid or HCN. As an antidote against the toxin, large amounts of molasses or milk can be taken.

The grains of many sorghum varieties have a dark layer in the central part containing the embryo sac which gives a sour, bitter taste, and a dark unattractive colour to flour produced from them. Yellow grains without the dark layer, however, give good quality flour, although the flour is sometimes coarse.

Among cereal grains, sorghum ranks second to maize in total available energy. The chemical composition is similar to that of maize. Because the husks are readily removed from most varieties, sorghum flours are low in fibre and ash. The protein content is usually higher than is found in rice or maize. The oil content is lower than in maize, but sorghum has about the same carbohydrate component as corn, with more tannin and wax.

The germ of the kernel contains 70 per cent of the oil, 15 per cent of the protein and 20 per cent of the ash. The horny endosperm contains more protein than the floury endosperm. A considerable portion of wax is concentrated in the bran, where most of the fibre is also found. Sorghum flour does not keep well; a bad odour and taste often develop within a short time.

The wax content of sorghum is about 0.25 per cent and can be extracted from unground whole grain with hot hexane. Sorghums are valued for their high starch content which ranges from 68–73 per cent. Varieties of sweet sorghum are sometimes grown as garden crops, and the stems are used like sugar cane. In some sweet varieties, the grains are not eaten. Softer, sweet-grained sorghum varieties are cooked and eaten whole, and those cut before they are ripe, because of shedding, are used in the form of rice. Sorghum grain flours are excellent when added to wheat flour in baking muffins, rolls and biscuits.

Local beers known as 'fito' and 'pito', are brewed from certain red varieties. These are usually grown specifically for brewing purposes. Bluish-grey grains which are also unsuitable for flour making, are used for the brewing of beer. The stems have many domestic uses including: dyeing, basket and mat weaving, fencing, thatching, and as supports for growing gourds, yams and beans.

2.2.3 *Rice*

Rice has been introduced to tropical Africa and has been widely adopted as a desirable food grain. There are two main types of rice grown, one under flood conditions (paddy rice), and the other ('upland rice') under dryer conditions. The different varieties are distinguished mainly by the shape and size of the grain; the presence or absence of bristle fibres or 'awn'; the colour of the kernel; and the time taken to ripen. There are long grained varieties which break very easily during cleaning. Medium or short kernel varieties also exist. The kernels are covered with a greenbrown husk. Rice grown in Africa may be brown, yellow or reddish, even when cleaned. The varieties which normally grow in swampy areas do not grow in upland areas.