

## Production and Utilization of Food Commodities in Kenya

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Kenya is an East African country with a total land area of 581,787 km<sup>2</sup> and a population of approximately 21 million. Of the total land, approximately 520,000 km<sup>2</sup> is utilized for agricultural production. However, most of the agricultural area falls into arid and semi-arid areas, having an annual rainfall of 612.5 mm or less. Only 19 % of the total agricultural area receives annual rainfall of more than 735 mm. The average annual rainfall of selected cities in eight provinces is shown in Table 1.

In addition to rainfall, temperature plays an important role in agricultural productivity. In Kenya, the altitude of arable area ranges between almost sea level to approximately 3,000 m above sea level and this influences the temperature of the given area.

As shown in Table 2, the warm zone with adequate rainfall is extensively utilized for agricultural production. This area exists in the Rift Valley, Central and part of the Eastern and Western Provinces. The arid and semi-arid zones, including the North Eastern province and part of the Rift Valley province, are mainly utilized for animal production.

Kenya's economic backbone is agriculture. The agricultural sector provides a base for her economic growth, employment creation and foreign exchange earnings. This sector contributed 26.2 % of real growth domestic product, while manufacturing and service sectors contributed 13.6

**Table 1** Average Annual Rainfall of Selected Locations in Kenya (1993)

Location of Meteorological Station	Province	Average Annual Rainfall (mm)
Upland	Nairobi	1,267.6
Mtwapa	Coast	1,093.9
Garissa	North-Eastern	260.0
Embu	Eastern	845.7
Nyeri	Central	898.8
Nakuru	Rift Valley	700.7
Kisumu	Nyanza	1,169.2
Kakamega	Western	1,674.2

Source: Statistical Abstract 1995, Central Bureau of Statistics.

% and 60.2 %, respectively, during the 1990~1995 period. Furthermore, agriculture is the major foreign exchange earner, second to tourism. The major agricultural exports include tea, coffee and horticultural crops as shown in Table 3.

### Cereals, Pulses and Oilseeds

Food legumes provide the bulk of calories and proteins for many Kenyans. There is little doubt of the importance of legumes and cereals in the diet, particularly of the low-income groups, which will increase rather than decline. Legume proteins, which are comparatively rich in lysine and low in sulfur amino acids, complement those of cereals, which are low in lysine but are comparatively rich

**Table 2** Land Utilization for Agricultural Production in Kenya (1994)

Province	Total Provincial Area (km <sup>2</sup> )	Land Utilization for Cereals Production (ha)	Land Utilization for Production of Temporary Industrial Crops (ha)	Land Utilization for Production of Permanent Industrial Crops (ha)	Land Utilization for Production of Fruits (ha)
Nairobi (Nairobi) <sup>1</sup>	684	86	—	2,836	3
Coast (Mombasa) <sup>1</sup>	83,603	73	—	47,681	1,192
North-Eastern (Garissa) <sup>1</sup>	126,902	—	—	—	—
Eastern (Embu) <sup>1</sup>	159,891	4,104	3	6,811	13
Central (Nyeri) <sup>1</sup>	13,176	4,430	49	35,068	7,960
Rift Valley (Nakuru) <sup>1</sup>	173,868	129,329	25,770	57,165	2,685
Nyanza (Kisumu) <sup>1</sup>	16,162	4,613	10,037	204	—
Western (Kakamega) <sup>1</sup>	8,360	381	982	—	—

<sup>1</sup>Name of City (Provincial Headquarters)

Source: Statistical Abstract 1995, Central Bureau of Statistics.

**Table 3** Export of Kenyan Products in Kenya £'000<sup>1)</sup>

Commodities	1990	1991	1992	1993	1994
Tea	314,505	381,630	474,908	933,659	844,069
Coffee, not roasted	220,996	218,428	206,339	551,510	652,897
Fruits and Vegetables	128,027	143,825	158,133	269,580	277,002
Sub-Total of Food, Beverage and Tobacco	772,659	830,459	945,519	2,008,220	2,124,963
Materials, Mineral Fuels and Lubricants	253,979	392,534	397,523	654,791	696,803
Manufactured Goods	207,351	359,028	429,472	919,298	1,345,939
Grand Total	1,232,360	1,533,831	1,708,085	3,625,206	4,170,724

<sup>1)</sup> K £1.0=20 Kenya Shillings=approximately 45 Japanese yen

Source: Statistical Abstract 1995, Central Bureau of Statistics.

in the sulfur amino acids methionine and cysteine. A combination of cereal and legume proteins, therefore, comes very close to providing an ideal source of dietary protein for human nutrition. The most important cereal staple in Kenya is maize ( *Zea mays* ). Legume grains consumed in substantial quantities include dry beans ( *Phaseolus vulgaris* ), cowpeas ( *Vigna unguiculata* ), pigeonpeas ( *Cajanus cajan* ), green grams ( *Vigna radiata* ) and field peas ( *Pisum sativum* ). The main oilseeds produced in Kenya are sunflowers ( *Helianthus annuus* ), coconuts ( *Cocos nucifera* ), samsims ( *Sesamum indicum* ) and cottonseed ( *Gossypium hirsutum* ). Other cereals of significance include wheat ( *Triticum* spp. ), rice ( *Oryza sativa* ), sorghum ( *Sorghum bicolor* ) and millet ( *Pennisetum* spp., *Panicum* spp., *Eleusine* spp. and *Setaria* spp. ).

#### 1. Production

The area under maize has stabilized at around 1.4 million hectares with limited potential for further expansion. The estimated production of cereal and legume commodities for the year 1995/96 in million bags (90 kg per bag) was as follows : maize 23.83, beans 2.82, sorghum 2.51 and millet 0.47. Although the average maize yield is currently 2 tons/ha, potential exists for increasing this to over 6 tons/ha through the use of improved seeds, fertilizers and good crop husbandry. The country also has the potential to produce enough wheat for local consumption, which is estimated at 6 million bags annually. However, due to various constraints the country is producing only 3 million bags currently.

#### 2. Utilization

The bulk of the maize is milled by roller-milling technology into a semolina-like product known as sifted maize meal. The requirements for this product (Kenya Bureau of Standards, 1979) are that it should contain maximum, by weight, of 0.7 % fiber, 3.0 % fat, 14% moisture and 0.75 % total ash. In the rural and peri-urban areas a substantial amount of maize is milled using hammer-mills and hand-operated machines to produce whole maize meal known as *posho*. The statutory requirements

for *posho* are that it should be made from cleaned maize, and shall not have an objectionable odor or contain foreign matter. The maximum allowable components are fiber 3.0 %, fat 5 %, moisture 14% and total ash 2.0 %. Maize meal is consumed as a gelatinized stiff paste known as *ugali* and as a thin porridge known as *uji* in Kiswahili, the national language of Kenya. *Ugali* is prepared by vigorously stirring maize meal into boiling water using a wooden spatula, until the meal is completely gelatinized and sufficient meal is added to give the desired stiffness to the paste. *Ugali* comprises the main dish during lunch and dinner meals and is normally consumed accompanied with a relish made of meat, vegetables, legume grains, a combination of these or with sour milk. A common lunch time meal for many Kenyan middle class people is *ugali* and roast meat ( *nyama choma* ). Porridge is usually consumed at breakfast time and is sometimes flavored with lemon juice, sugar or sour milk. Maize is also consumed as whole boiled grain admixed with legume grains, green leafy vegetables and potatoes. In some communities, maize is decorticated using a pestle and mortar prior to grinding into meal or boiling whole with the ingredients enumerated above.

Sorghum and millet are traditionally milled into meal and used to prepare *ugali* or *uji*. Some porridge is fermented. Sorghum and millet are also used to manufacture traditional alcoholic beverages such as *busaa*. Efforts have been made to introduce abrasive milling technology for sorghum and millet with the aim of manufacturing more sanitary products that are pre-packaged to appeal to the urban dwellers. Recently, there has been renewed interest in the commercial, albeit small-scale, production of alcoholic beverages based on sorghum and millet using modern technology and a number of brands such as *kibuku*, *sorghum sake* etc. are currently being marketed.

Legume grains are mainly threshed and consumed as whole grain after cooking. The small-scale processing of legumes in Kenya has had little impact with only small quantities being converted into *dhal* (decorticated, split grain legume). The

**Table 4** Extractability, purity and chemical composition of cowpea and pigeonpea starch fractions<sup>1</sup>

Property (%)	Starch	
	Cowpea	Pigeonpea
Extractability (db) <sup>2</sup>	51.49 ± 0.23 <sup>a</sup>	29.07 ± 0.85 <sup>b</sup>
purity (db)	94.19 ± 1.17 <sup>a</sup>	97.04 ± 0.20 <sup>a</sup>
Moisture	6.69 ± 0.05 <sup>a</sup>	6.52 ± 0.04 <sup>a</sup>
Crude protein (db)	0.51 ± 0.13 <sup>a</sup>	0.51 ± 0.14 <sup>a</sup>
Crude fiber (db)	1.08 ± 0.01 <sup>a</sup>	1.07 ± 0.01 <sup>a</sup>
Ash (db)	0.04 ± 0.01 <sup>a</sup>	0.04 ± 0.00 <sup>a</sup>
Crude lipid (db)	0.15 ± 0.04 <sup>a</sup>	0.07 ± 0.02 <sup>a</sup>
Total amylose (db)	31.03 ± 0.14 <sup>a</sup>	29.62 ± 0.35 <sup>b</sup>
Trypsin inhibitor	ND <sup>3</sup>	ND
Phytate	ND	ND
Oligosaccharide	ND	ND

<sup>1</sup>Means in a row followed by the same letter are not significantly different (P < 0.05)

<sup>2</sup>db = dry basis

<sup>3</sup>ND = not detected

Source: MWASARU, M. A., Effects of extraction conditions and solvent environment on the functionality of the food macromolecules of pigeonpeas and cowpeas. Ph. D. Dissertation, University Pertanian Malaysia, 1996.

most common mode of preparing legumes is to boil them, preferably after soaking, with maize and/or potatoes. The legumes can also be used to prepare a savoury relish for *ugali*, *chapati* or rice following boiling and frying admixed with spices and herbs. Preliminary investigations have been carried out on the possibility of fractionating the major food macromolecules of the grain legumes. The results obtained so far indicate that cowpeas and pigeonpeas can be processed using a wet milling technique to yield starch of high purity that possesses characteristics suitable for the manufacture of glass noodles (Table 4). The protein fractions extracted using an isoelectric precipitating technique were found to exhibit physicochemical and functional properties which compared favorably to those of a commercial soybean protein isolate and can, therefore, supplement or even replace the latter in a variety of food applications.

Four main oilseeds, namely sunflower, cotton, simsim and coconut, are grown in Kenya for the manufacture of edible oils. In addition, corn oil is

**Table 5** Production of oilseeds

Oilseed	Area cultivated (Ha)	Production (MT)
Sunflower	3000	5000
Simsim	4600	700
Rapeseed	4700	1400
Coconut	42000	5400
Maize germ	—	4900

Source: Ministry of Agriculture Annual Reports 1978, Nairobi, Kenya.

produced from germ as a by-product of maize milling. The areas under oilseed cultivation and production are given in Table 5. The average per capita intake of oils and fats in Kenya is about 5.6 kg per annum which is equivalent to 138 kcal per day derived from visible fats. Additional calories are derived from invisible fats giving a total of 345 kcal per day derived from total fats. This represents less than 20 % of total dietary energy, a figure that is less than the 25 ~ 30 % recommended by the FAO and WHO. There are about 35 vegetable oil extraction and refining plants distributed throughout the country. Most of these plants utilize screw-exPELLER technology with only two plants utilizing the solvent extraction process. The overall capacity utilization in the edible oil processing sector is less than 50 % and this is attributed to the erratic and often unreliable supply of raw materials. Rural oil processing is not well established in the country, with only a few units in existence operated by non-governmental organizations. The factors contributing to the low participation of rural-based enterprises in the edible oil industry include a lack of raw materials, unfair competition from imported oils, and a lack of concrete government policy on oil crop production and processing. As a consequence of the lack of clear cut policies and an incentive framework, 95 % of Kenya's domestic edible oil requirements are met by importation at a cost of K£ 200~300 million annually. Palm oil accounts for about 31 % of the total imports with the remaining portion made up by soya, groundnut rapeseed and coconut oils.

The demand for edible oils has been growing

about 13 % annually between 1978 and 1992. Many constraints have been identified as the causative factors of the poor performance of the edible oil sector including poor producer prices, poor transport infrastructure, lack of input support to oilseed producers, excessive government interference and lack of a co-ordinating mechanism for the sector. In the 1997 ~ 2001 Development plan, the government plans to establish an Oilseed Development Council to spearhead the planning and implementation of strategies aimed at revitalizing the edible oil industry. In addition, the government plans to review import tariffs to encourage local production and mitigate against reliance on importation. The demand of oils and fats is projected to increase in tandem with population growth, the increase in income, and urbanization. It is envisaged that increased local production will lead not only to an increase in the per capita consumption of oil but will also benefit the animal feed industry, since the by-products of the oil industry are important inputs for the feed manufacturing sector.

### Fruits and Vegetables

#### 1. Production and postharvest handling

1) **Fruits** By virtue of geographical location, Kenya grows many tropical and subtropical fruits. These include mango, avocado, pineapple, passion fruit and papaya, which are Kenya's most important export fruits. Other fruits include bananas, citrus, tree tomato and guava among others (Table 6). Most research on these commodities has been focused mainly on fertilizer application and disease control with little attention being given to their postharvest handling, despite the realization that as high as 50 % of the produce is lost during the postharvest period. This loss may even rise to 80 % for some commodities, especially when they are in season. Temperate fruits are also grown in Kenya, mainly on the highlands. Those which have shown economic potential are apples, pears, plums, peaches and apricots. Small fruits such as strawberries, grapes,

**Table 6** Estimated production of horticultural crops in Kenya for 1990 and 1991

Crop	Production (metric tonnes)	
	1990	1991
Banana	920,513.0	1,026,275.9
Citrus	189,001.5	190,874.9
Mangoes	76,686.8	93,993.9
Avocado	23,042.7	18,709.6
Passion fruit	8,380.3	16,255.8
Pineapple	376,363.0	378,704.5
Papaya	43,740.5	44,593.4
Plums	4,147.0	5,550.0
Peaches	980.5	2,291.0
Pears	6,736.0	8,059.0
Watermelon	3,308.0	3,152.8
Strawberries	1.0	1,841.5
Guavas	3,956.3	2,343.5
Grapes	13.3	165.0
Cabbage	293,894.0	363,860.5
Tomatoes	177,309.0	118,414.0
Kale	183,504.0	220,531.7
Onions	68,622.5	73,139.6
Carrots	59,744.2	63,030.0
French beans	13,565.2	28,644.5
Spinach	2,641.3	4,797.5
Lettuce	3,208.8	2,581.5
Cucumber	788.0	1,751.0
Traditional vegetables	16,329.0	13,341.5

Source : Ministry of Agriculture, Kenya, Horticultural Crops Division, 1990/1991 Annual Report.

blackberries, mulberries and cape gooseberries are also grown but to a lesser extent.

2) **Vegetables** The main vegetables grown are potatoes, kale crops (*Brassica* spp.), tomatoes, peppers, onions, carrots, beans, peas and squash among other, as shown in Table 6.

Besides the common vegetables, there is a wide variety of traditional vegetables grown and consumed locally. They include the blacknight shade, pumpkin leaves, cowpeas, pigeon peas, crotonaria, amaranthus, spiderweed, okra, cassava and sweet potatoes.

**Table 7** Annual export volume (in 1000 tonne) for Kenyan fresh horticultural exports, 1987~1992

Crop	1987	1988	1989	1990	1991	1992
Pineapple	0.9	16.7	3.2	0.8	0.6	0.6
Mango	1.9	3.5	3.0	2.6	1.7	2.3
Avocado	2.0	3.8	3.4	3.3	1.7	6.3
Strawberry	0.2	0.6	0.8	0.6	0.4	0.3
Passion fruit	1.2	0.7	0.4	0.4	0.6	0.7
Papaya	0.1	0.1	0.1	0.09	0.07	0.09
Lemon, lime	0.06	0.06	0.04	0.03	0.03	0.04
Other fruits	0.7	0.5	0.3	0.3	0.6	0.8
French beans	9.8	12.0	15.2	16.3	14.9	15.2
Peppers	0.04	0.04	0.03	0.03	0.01	0.3
Asian vegetables	9.6	8.4	8.6	9.2	9.2	9.4
Tomatoes	0.3	0.2	0.2	0.1	0.1	0.07
Other veg.	0.5	0.5	0.4	0.3	0.4	0.6
Root crops	0.2	0.1	0.05	0.05	0.04	0.05

Source : Horticultural Crops Development Authority and Kenya Export Development Support Project Report-Kenya Horticultural Subsector Survey (1992).

The production and processing of traditional vegetables has not been expanding rapidly compared to the exotic types. Generally, traditional vegetables have desirable attributes in foods, such as imparting unique tastes, aromas and medicinal properties. Some of the traditional vegetables, such as cassava and sweet potato, are used as staple foods in some parts of the country.

**3) Export market** Horticulture is one of the major farming activities in Kenya, providing food, income and employment for the rural population. Export has grown from 3,224 tons in 1970 to 22,266 tons in 1980 and 57,363 tons in 1992, as shown in Table 7. These production values could be increased two to three fold if harvesting and postharvest handling systems could be improved. For example, the export of pineapple has declined over the years due to postharvest handling problems. The main problem has been development of brown heart, which cannot be detected visually until the fruit is cut. Thus, there is a big difference between the volume of the commodity produced and that exported. The

produce that is not exported is sold in the local market both as fresh fruit or in a processed form. However, most of these marketing establishments do not have adequate storage facilities and, therefore, cannot handle all the products in the market.

Most of the Kenyan produce is exported to Europe and the Middle East. Currently the major constraint to horticultural export are inadequate know-how in postharvest handling systems, limitation of air cargo, lack of adequate cold facilities and quality control. Plans are, however, underway to evaluate transport of produce by sea and to construct cold storage facilities. Several private and public institutions are now actively involved in the horticultural industry. The Horticultural Crops Development Authority (HCDA) was established in 1967 as a statutory body to promote and expand the export of horticultural crops. HCDA provides materials, technical information and other services to Kenya's horticultural industry to improve the quality of horticultural exports.

## 2. Processing

Processing of fruits and vegetables in the country has witnessed rapid expansion in recent years. The growth is attributable to the improved infrastructure in many parts of the country and to technological advances in the field of food processing. These factors, among others, have facilitated the increasing numbers of small-scale and intermediate-scale processing systems and the expansion of large-scale processing facilities.

**1) Canning** Canning is among the oldest methods of processing fruits and vegetables in the country. Among the canned fruit products, pineapple is the most important. The largest factory for canning pineapple slices is owned by Del Monte Kenya Limited and is located in Thika town, about 45 km from Nairobi. The company's pineapple farm adjacent to the cannery is one of the largest of its type in the world. Most of the canned pineapples are exported. Other prominent canned products are green peas and French beans and tomatoes, mainly undertaken by the Kabazi Cannery factory in Nakuru town.

**2) Juices** Processing of fruit juice is the most rapidly expanding sector of the fruit and vegetable processing industry. Juices from various fruits are extracted and pasteurized for local and export markets. The juices are packed in paper cartons or plastic bottles. The processing is mainly undertaken by small-scale enterprises and there appears to be much interest and market potential for expansion of this sector. The common juices are made from various types of fruits, including passion fruit, orange, mango and pineapple.

**3) Preserves** The main types of fruit preserves processed in the country for local consumption and export are jams, jellies and marmalades. The production is mainly undertaken by small-scale enterprises across the country. The main large scale processing factories are the Kenya Orchard near Machakos town, TruFoods in Nairobi and Kenya Fruit Processors in Thika town. The preserves are made from guavas, plums, papayas, strawberries and citrus fruits, among others.

**4) Dried Fruits and Vegetables** Some fruits and vegetables are dried on a small-scale for the local or export markets. These include mangoes, pineapples, bananas, carrots, cabbages and onions. The largest vegetable dehydration factory is owned by the Pan African Vegetable Company in Naivasha town. There is a high potential for further development of this sector of the fruit and vegetable processing in the country.

## Meats and Meat Products

Traditionally, the keeping of livestock in Kenya, as in other African countries, was valued more for its social significance than for any economic advantage. Cattle, sheep and goats were used for dowry, settlement of disputes and other ceremonies and rituals. The possession of large numbers of livestock was viewed as a sign of wealth and hence much importance was paid to quantity rather than quality. Even today, several communities, such as Maasai and Samburu still believe in keeping such large numbers of animals. However, with more economic awareness and vigorous development of the livestock industry in Kenya, a higher quality of animals are now sought and many ranchers apply scientific techniques in their animal husbandry.

Until the advent of colonialism, only indigenous livestock species were kept. The main advantage of these animals is their ability to resist several diseases and to withstand adverse conditions such as heat, little water and poor pasture.

With the increase in the economic value of livestock, the demand for better quality animals has increased. The government has set up policies aimed at improving animal husbandry per se and also improving the animals genetically. Institutions concerned with improvement of Kenyan livestock include the Kenya Agricultural Research Institute (KARI), Center for Artificial Insemination (CAIS), and the Ministry of Agriculture, especially for training of technical personnel, as well as universities and other affiliated institutions.

**Table 8** Total animal numbers in Kenya, 1988~1990  
(000 Heads)

Category	1988	1989	1990
Beef	13,050	13,457	13,793
Sheep	6,317	6,325	6,516
Goats	7,000	7,500	8,000
Pigs	97	100	105
Camels	790	800	810
Chicken	23	24	25

Source : Statistical Abstract 1995, Central Bureau of Statistics.

## 1. Production

**1) Cattle** These include improved African breeds such as the East African Zebu and breeds introduced from Europe and India that have been adapted to local conditions. They may be divided into three types such as the (i) beef type for meat, including Hereford, Shorthorn and Aberdeen-Angus, (ii) the milk type such as Freisian, Ayrshire and Channel Islands, used mainly for milk production, and (iii) the dual purpose type, including those which produce more meat than the dairy type and more milk than the beef type, for example, Dairy Shorthorn, Redpoll and South Devon. Several Indian types are also available for beef or as dual purpose such as Sahiwal. Zebu such as Kenya Boran, though now recognized as a breed, is a local breed which, through genetic improvement, is able to produce more meat and milk of higher quality.

**2) Sheep** Both indigenous and introduced breeds are now well established. Exotic breeds which supply for both meat and wool are reared in the cool, highland areas in the Rift Valley and Central Provinces. The local breeds which are well adapted are found all over the country, including the arid and semi-arid regions.

**3) Goats** These are animals that are very well adapted to all regions of the country and are viewed as a valuable source of meat. They are also kept for traditional wealth as the local cattle breeds. Apart from this, they are resistant to most diseases and worms. They also require minimum attention, do well in adverse environments and

serve as a source of milk.

**4) Pigs** Compared with cattle, sheep and goats, pigs are a relatively recent introduction into the Kenyan livestock scene. All breeds are imported and improved for adaptability to local conditions. Production is solely geared towards the pig processing industry and farmers concentrate on production of baconers, porkers and sausage pigs.

**5) Poultry** As with the pig industry, commercial poultry rearing for meat and eggs is relatively recent in Kenya. The native fowl is a common feature of every homestead in rural Kenya. It has also now been improved to produce a marketable size for meat. Ducks and turkeys are also kept by a few farmers, especially for the food service and processing industries.

**6) Others** Camel keeping is practiced among the communities of the North Eastern districts. They are primarily used for transportation and also as a source of meat and milk. Rabbits are kept especially by farmers in Kiambu district of Central province to provide meat and fur.

## 2. Utilization

**1) Slaughter** Slaughtering of cattle, sheep and goats is carried out by licensed abattoirs throughout the country. Large commercial slaughter houses such as the Kenya Meat Commission previously played an important role in providing hygienic meat and meat products for local and export markets. Commercial slaughter is carried out by private slaughter houses whose products are aimed at the processing industry and export, particularly to the Arab Gulf States. Sheep and goats are also sold live to individuals who slaughter them at home, but this practice is not encouraged by the government. Numbers slaughtered are shown in Table 9, which indicates an increase of about 90 % in the number of cattle slaughtered and 50 % for sheep and goats between 1987 and 1994.

The main slaughtering plant for pigs is the Farmers Choice Company, which is a pork processing plant and supplies both fresh pork and

**Table 9** Livestock purchases for slaughter by all licensed abattoirs ; 1987~1994 (000 Heads)

Category	1987	1988	1989	1990	1991	1992	1993	1994
Cattle and calves	524	701	752	828	969	755	801	901
Sheep and goats	875	942	998	1,206	1,345	1,073	1,113	1,310
Pigs	60	63	73	84	83	73	75	91

Source : Statistical Abstract 1995, Central Bureau of Statistics.

its products to local and export markets. Others include the Nairobi Airport Service. There was an increase of 50 % in the number of pigs slaughtered between 1987 and 1994. Commercially produced broiler chickens are slaughtered at the Kenchic Factory, which is the only factory of its kind in Kenya.

**2) Processing** In Kenya, most meat is marketed in fresh form. Meat shops obtain freshly slaughtered certified carcasses from the slaughter houses. High-class meat shops chill and freeze the carcasses, prior to boning and sale. Conventional aging / conditioning of carcasses before boning is carried out only at large commercial establishments which also process products like beef sausages, corned beef, beef extract, and a variety of canned meats for both local and overseas markets. In the market centers and rural areas, carcasses are sold immediately after slaughter.

As most pork is slaughtered in large commercial factories, conventional aging follows immediately after the slaughter and public health certification. Most carcasses will be conditioned for 1 to 2 weeks, depending on demand and, thereafter, the meat is cut into primals or retail cuts, according to orders received. This may be for fresh sales or processed products such as bacon and ham. The lower grades are manufactured into sausage-type products for local and export markets. A variety of delicatessen meats incorporating turkey meat, beef and other specialty products are also produced mainly for the airline industry.

After slaughter at Kenchic, broilers are graded according to size and chilled before sale. For orders originating abroad or in distant local towns

such as Mombasa, the chickens are further frozen to  $-20^{\circ}\text{C}$  before transportation.

### Traditionally Fermented Beverages

In Kenya, fermentation of food is mainly based on cereals and milk. Each community in the country has developed its own technology of making the fermented beverages and most of these beverages are restricted to domestic consumption.

#### 1. Alcoholic beverages

Honey and sugarcane juice are widely used in Kenya to produce fermented beverages (mead and opaque beer). Fermentation times for these beverages are very variable. Their fermentation may generally suffer due to the low content of nitrogen compounds and mineral salts and the presence of natural antibiotic components in honey. There are two types of alcoholic beverages in Kenya depending on the source of raw materials and the method of production. These are *muratina* and *busaa*.

**1) Muratina** *Muratina* is a mead made from sugar cane juice and honey. It is named after the fruit fiber of an indigenous tree *muratina* (*Kigeria africana*). The mead is fermented in gourds containing the *muratina* fruit fibers. The fibers act as yeast immobilizers and also give the mead some characteristic bitter taste. This alcoholic beverage is common in central and eastern regions of Kenya where it is restricted to domestic use. Fermentation of *muratina* takes two days at  $37\sim 42^{\circ}\text{C}$  in gourds kept beside the fireplace. Another version of this beverage is the one known as *miti* made by naturally fermenting honey in assorted herb extracts for about 10 days at ambient temperature ( $25\sim 30^{\circ}\text{C}$ ). *Miti* is supposed to have

indeterminate therapeutic effects. The alcohol content of these beverages is not standardized, but ranges between 3.5~7.5 % v/v.

**2) Busaa** For the manufacturing of *busaa*, sorghum is steeped in water and left to germinate for four days to produce malt which is then dried and milled into flour which is then roasted. Water is added to the roasted flour and left to ferment naturally. Fermentation is fast (8~12h) and the final beer is brown in color with an alcohol content of about 4.5 % v/v. Commercial production of this opaque beer is established as *Nyuki* and *Kibuku*.

## 2. Non-alcoholic beverages

**1) Uji** Uji is made by boiling fermented cereal flour. The cereals commonly used include sorghum, millet and maize. Traditionally, the cereals are mashed using a wooden pestle and mortar, and water is added to make a paste. The paste is diluted with water, put into gourds and left overnight to ferment. The resulting porridge is sour due to lactic acid fermentation.

**2) Ododo** *Ododo* is made by fermenting milk together with boiled indigenous vegetables. The vegetables are boiled and then milk is added. The mixture is left to ferment for a day or two before some more milk is added. This procedure is repeated for a maximum of two weeks. Finally, the product is boiled again and served hot. This type of fermented food is common in the Nyanza province of Kenya.

**3) Egechieto** This food is common in Kisii, Nyanza province and is made from bovine blood and milk. Blood from a slaughtered animal is heated on a pan and milk is added. This is left to ferment naturally for a day or two. The product is dark brown in colour. A similar product (*osarui*) is produced by the Maasai community using raw blood.

**4) Mala** Sour milk is known as *maziwa lala* in the Swahili language and this is shortened to *mala*. Fermented milk in Kenya has a long history and has formed an integral part of the African culture. Studies indicated that 53 % of the milk produced in the cooler highlands is consumed as fermented milk. Production and consumption of

fermented milk is a daily undertaking in arid and semi arid areas of Kenya. Although sour milk processing and marketing has been commercialized by many companies, most sour milk taken in Kenya is traditionally fermented. The Maasai and Kalenjin communities fermented their milk in gourds which have been treated with charred herbs. Kalenjin type fermented milk is known as *mursik*, and unlike the Maasai one, is black in colour when ready due to the charcoal in the gourd from the charred herb. A gourd specifically prepared for fermenting *mursik* is washed with warm water with the aid of a cured stick obtained from palm branches. When the gourd is dry, it is rubbed inside with a burning end of the herb. The rubbing effect makes the charcoal break inside. Raw milk is then put into the treated gourd and left to ferment for 7~10 days. The whey which separates is drained and more raw milk is added. The process is repeated until there is no more whey. Ripening follows which can take up to 12 months and the resultant *mursik* is viscous like yoghurt. In the Maasai traditionally fermented milk (*kule naaoto*), the gourd is washed as described above. After drying, a burning splint is inserted in the gourd and shaken vigorously closing the mouth by hand. The broken pieces of wood and charcoal are removed. Raw milk is then added and left to ferment naturally for one week. *Kule naaoto*, unlike *mursik*, is lighter in colour with a smoky sour taste.

## Reference

- 1) Statistical Abstract, Central Bureau of Statistics, Office of the Vice-President and Ministry of Planning and National Development, Government of Kenya (1995)
- 2) Kenya, Land of Opportunity, Central Bank of Kenya (1991)
- 3) Economic Survey, Central Bureau of Statistics, Office of the Vice-President and Ministry of Planning and National Development, Government of Kenya (1996)
- 4) The Eighth National Development Plan for the Period of 1997~2001, Republic of Kenya

- 5) Kenya Bureau of Standards, Kenya Standard Specification for Milled Maize Products KS 05-168, p. 4 (1979)
- 6) MWASARU, M. A. : Effects of extraction conditions and altered solvent environment on the functionality of the food macromolecules of pigeonpea (*Cajanus cajan* L.) and cowpea (*Vigna unguiculata* L.) Ph. D. Dissertation University Pertanian Malaysia, Serdang, Selangor, Malaysia (1996)
- 7) MWASARU M. and NYAMBATI M. : Development of new sorghum foods in Kenya. *J. Food Agric.*, 1, 57~60 (1987)
- 8) The Republic of Kenya, The 8<sup>th</sup> National Development Plan 1997 ~ 2001, Government Printer, Nairobi, Kenya, p. 254
- 9) The Republic of Kenya. Statistical Abstract, Central Bureau of Statistics, Ministry of Planning and National Development. Nairobi, Kenya (1996)
- 10) ABE, K., MATHOOKO, F. M., KIIYUKIA, C., KOAZE, H., MUIGAI, C. W. and MWANIKI, M. W. : Surveillance of postharvest handling of perishable food crops in Kenya, Technical Report, Department of Food Science and Postharvest Technology, Jomo Kenyatta University of Agriculture and Technology, Kenya (1996)
- 11) ABE, K., MATHOOKO, F. M., KIIYUKIA, C., MWANIKI, M. W., MUIGAI, C. W. and KOAZE, H. : Topics of fruits and vegetables markets in Kenya, *J. Jap.Ass. Food Preser. Sci.*, 23, 89~95 (1997)
- 12) Food and Agriculture Organization. Food loss prevention in perishable crops. FAO Agric. Serv. Bul. 43 (1981)
- 13) Kenya Ministry of Agriculture, Horticultural Crops Division, 1990/1991 Annual Report.
- 14) KOAZE, H. and MATHOOKO, F. M. : Postharvest handling methods of food crops in Kenya. Technical Report, Department of Food Science and Postharvest Technology, Jomo Kenyatta University of Agriculture and Technology, Kenya (1991)
- 15) MATHOOKO, F. M. and KOAZE, H. : Postharvest handling of perishable food crops in Kenya-The present situation and future prospects. In : Proceedings of National Seminar on Technological Solutions for Economic Development in Kenya-Now and 21 st Century. pp. 477~489 (1991)
- 16) MUKAI, M. K. : Postharvest research in a developing country : A view from Brazil. *Hort. Science*, 22, 7~9 (1987)
- 17) M'RIBU, H. K., NEEL, P. L. and FRETZ, T. A. Horticulture in Kenya : An overview. *Hort. Science*, 28, 766, 870~871 (1993)
- 18) M'RIBU, H. K., NEEL, P. L. and FRETZ, T. A. : Horticultural research in Kenya, *Hort. Science*, 28, 770~773 (1993)
- 19) FAULKNER, D. E. : Notes on animal health and industry for Africans. The Government Printer, Nairobi (1957)
- 20) COLE, M. L. : A farm on the wildside. *New Scientist*, 127, 62~70 (1990)
- 21) HOPCRAFT, D. : Wildlife ranching in perspective. In Proceedings of a workshop on wildlife disease research and economic development. Kabete, Kenya. p. 68. IDRC. (1980)
- 22) SOMMERLATTE, M. and HOPCRAFT, D. : The economics of game cropping on a Kenyan ranch 1981~1990. *Pelea*, 13, 71~79. (E. Cape South Africa) (1994)
- 23) TALBOT, M. L., PAYNE, W. J. A., LEDGER, H. P., VERDCOURT, L. D. and TALBOT, H. M. : The meat production potential of wild animals in Africa : A Review of Biological Knowledge. Technical Communication #16. Commonwealth Agricultural Bureaux. Farnham, Bucks., England (1965)
- 24) IZUMIMOTO, M. : Kenya and it food situation. *Shokuniku no Kagaku*, 37, 223~229 (1996)
- 25) SHALO, P. L. and HANSEN, K. K. : Maziwa lala - A fermented milk. *World Animal Rev.*, 5, 32~37 (1973)
- 26) PONS, M. N. and SCHUTZE, S., : On-line monitoring of volatile compounds in honey fermentation, *J. Ferm. Bioeng.*, 78 (6), 450~454 (1994)
- 27) MATHARAA, J. M., MIYAMOTO, T., KOAZE,

H., KIIYUKIA, C. and YONEYA, T., : Production of traditional fermented milk in Kenya, *Shizuoka*

*Prefectural University Research Bulletin*, 9, 257~264 (1996)

### ケニアにおける食料の生産と利用

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ケニアにおける経済的基盤は、農業であり、1990～1995年の資料によれば、農業生産は国内総生産額の26.2%を占め、工業生産は13.6%、サービス業は60.2%を占めている。この傾向は今後も続くと考えられ、ケニアの農業生産の事情と特質を世界に広く知らせ、輸出の拡大を図る必要がある。本稿ではケニアにおける穀物、豆類、油料種子、果実・野菜、肉類などの生産、加工、利用および輸出、ならびに伝統発酵飲料の製法の特徴と利用について解説した。