NATIONAL OPEN UNIVERSITY OF NIGERIA

AFS 202

Introduction to Food Science and Technology

Module 3

AFS 202 (Introduction to Food Science and Technology**) Module 3**

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Unit 1 Composition and Structures of Nigeria and West African Foods

1.0 Introduction

The fundamental purpose of Food Technology is to preserve food from deterioration and to present it to the consumer in a digestible and nutritious form to the ultimate consumer. A secondary interest of the Food Technologist, is that of modifying the quality of food stuffs so that they may become acceptable and attractive to the people for whom they are intended. However, the extent to which this can be done depends, to a large extent, on the nature of the commodities, their composition and technologies available for processing it.

2.0 Objectives

By the end of this unit, you should be able to:

- discuss the nutrient composition of some Nigerian African foods
- classify the foods according to their composition e.g. energy foods, proteinous foods and fatty foods
- relate the composition of foods to the use of therapeutic diets.

3.0 Main Content

3.1 Nutrient Composition of Some Nigerian Foods

3.1.1 Moisture Content

The Moisture content of Nigerian/African foods may fluctuate greatly with season, length of storage, etc. In calculating energy values of food, moisture contents must be accurately determined and subtracted from whole to estimate total dry matter. Water in itself does not provide either nutrients or energy.

3.1.2 Food Energy

The energy values of the foods represent the available energy calculated by the specific Atwater factors for protein, fat, and total carbohydrate by difference, which is obtained by subtracting the sum of the figures for moisture, protein, fat, and ash from 100. These factors have taken into account the losses in digestion and metabolism.

3.1.3 Protein

The values for protein were computed from the nitrogen content as determined by the Kjeldahl method, multiplied by a conversion factor. From the fact that most proteins contain approximately 16 per cent nitrogen, protein contents were calculated with the factor 6.25 for the conversion of nitrogen to protein.

For those foods in which the protein is known to differ from this figure, the specific factors for converting nitrogen, as suggested by Breese Jones and listed below:

Foods	Factors for Converting Nitrogen to Protein
Milk	6.38
Groundnut	5.46
Soybeans	5.71
Nuts and Seeds	5.30
Rice	5.95

3.1.4 Vitamins

Apart from the macro nutries of Carbohydrate, Proteins and Fats Foods supply micronutrients in form of Vitamins and Minerals.

The Vitamins are divided into two major groups: (a) FAT SOLUBLE and (b) WATER SOLUBLE, Ascorbic acid or Vitamin C belongs to both groups.

The FAT Soluble Vitamins

Vitamin A,
Vitamin D,
Vitamin E
And Vitamin K

The Water Soluble Vitamins Thiamine (B1), Riboflavin (B2), Pyridoxal Phosphate (B6), Niacin, Pantothenic Acid, Folic Acid, and Vitamin B_{12}. Vitamin C is both water soluble and fat soluble because it is retained in the blood plasma where its level can be estimated.

3.1.5 The Minerals

The micronutrients known as minerals also occur in foods in minute amounts but are very essential for body metabolisms. They act as catalysts and coenzymes to facilitate body reactions in intermediary metabolisms. Examples of minerals include Sodium (Na); present in abundance in common salt (Nacl.); Potassium (K); Calcium (Ca); Iron (Fe); Phosphorus (P); Magnesium (Mg).; Iodine (I_2); Zinc (Zn); Cobalt (C_o); and Sulphur (S).

3.2 Proximate Composition of Cereal Products

		Waste g	Moisture %	KJ g	Kcal g	Protein g	Fat		Carbohydrates				Alcohol g	Ash g
							Total g	Chol	Total g	Mono g	Poly g	Fibre g		
1.	Maize, white whole, dried	0	10	1722	412	10.7	4.1-	-	88	-	-	0.4	0	2.7
2.	Maize, fresh boiled	-	59	1170	280	5.0	2.1	-	60	-	-	-	-	-
3.	Maize Eko/ Agidi	-	79	585	140	1.9	1.2	-	30	-	-	-	-	-
4.	Corn flakes	0	8	1313	314	8.9	1.2	-	67	32	63.5	1.1	0	-
5.	Maize, Egbo	-	60	1484	355	6.0	30.7	-	14	-	-	-	-	-

6.	Maize, 'Gug uru', roast ed	-	5	1756	420	8.1	5.0	-	86	-	-	-	-	-
7.	Maize, yello w, dried	-	10	1714	410	10.7	4.0	-	83	-	-	1.3	0	3.7
8.	Maize while toast ed/ roast ed	-	16	1605	384	11.0	3.1	-	76	-	-	1.7	-	1.5
9.	Maize roast ed paste (kok oro)	-	2	2115	506	8.8	23.4	-	65	-	-	-	-	2.8
10.	Maize Pap, ferm ented gruel "Ogi"	-	41	1731	414	11.5	39.0	-	83	-	-	1.1	-	0.4
11.	Rice, polis hed	0	10	-	-	9.1	0.1	-	-	-	-	0.3	-	0.6
12	Rice, boile	0	70	52	12	2.2	0.	-	30	0	30.	0.	-	-

.	d			2	3		3				0	8		
13.	Bread White Bread	0	39	991	233	7.8	1.7	-	50	1.8	48.0	2.7	-	-
14.	Spaghetti	0	72	499	117	4.2	0.3	-	26	0.8	25.2	-	-	-

Source: Oguntona and Akinyede, (1995).

Cereal products refer to grains from plant sources and include Acha grain, maize, white, whole, dried, Maize freshly boiled, maize prepared into Eko/Agidi; maize roasted "Guguru", maize yellow, dried; maize white roasted, maize roasted and made into paste "Kokoro", maize papa, fermented gruel "OGI'. Others are Millet finger, Millet bulrush grain; and Millet pap, gruel. Rice is also a cereal, Rice, brown raw, Rice polished, and rice boiled, fried or oil mixed "Jollof". Others are sorghum grain and sorghum, pap/gruel. The most popular cereal is wheat grain from which bread is produced. "Give us this day our daily bread". Wheat grain can be boiled; wheat flour can be produced; wheat bread white or brown; and assorted wheat confectionaries can be produced. Spaghetti is a cereal product which can be boiled and eaten as such. Mane breakfast cereals are known such as cornflakes, Granuola and Rice cripies. Most baby complementary foods or weaning foods are prepared from cereals mixed with milk e.g. Cerelac and Bebena or mixed with vegetable proteins e.g Nutrend.

3.3 Proximate Composition of Roots and Tubers

		Waste g	Moisture %	KJ g	Kcal g	Protein g	Fat		Carbohydrates				Alcohol g	Ash g
							Total g	Chol	Total g	Mono g	Poly g	Fibre g		
1.	Cassava bitter, peeled, raw	26	72	1634	391	2.6	0.5	-	94	6.7	81.4	1.4	-	1.3
2.	Cassava grated	-	14	1605	384	1.2	0.4	-	94	6.2	98.6	2.3	-	2.1
3.	Cassava Flour	-	13	1618	387	2.2	0.9	-	93	-	-	1.4	-	2.9
4.	Cassava sweet, peeled, raw	-	72	1572	376	1.7	0.7	-	91	-	-	1.6	-	5.2

5.	Cocoyam	-	68	1618	387	5.4	0.4	-	90	-	-	1.8	-	2.0
6.	Cocoyam	-	-	-	-	-	-	-	-	-	-	-	-	-
7.	Cocoyam	-	67	1626	389	5.1	0.5	-	91	-	-	1.6	0	1.8
8.	Potato Irish, peeled, raw	14	78	315	75	1.7	0.1	-	18	1.0	17.0	0.6	-	1.6
9.	Potato Irish, boiled	4	79	318	76	1.6	0.1	-	18	0.7	17.6	2.0	-	-
10.	Potato, sweet, white, peeled cooked	-	71	1635	391	5.2	0.5	-	92	-	-	0.1	-	2.7
11.	Yam, water, peeled raw	-	76	1559	373	7.3	0.6	-	86	-	-	2.3	-	4.0

12.	Yam, water, peeled grated (Ojojo)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13.	Yam, water, peeled raw	-	70	1593	381	5.3	0.3	-	90	-	-	1.5	-	2.7	
14.	Potato, sweet, white, peeled cooked	-	64	1613	386	5.0	0.4	-	91	-	-	0.6	-	3.4	

Source: Oguntona and Akinyede, (1995).

The composition of roots and tubers include the cassava species, cassava bitter, peeled, raw' cassava grated, fermented, dried "Garri"; Cassava meal, fermented and cooked, "Eba"; cassava flour; "Lafun"; cassava sweet, peeled, raw; Cocoyam (Tania), peeled cooked, cocoyam (Taro) peeled, cooked; potato irish, peeled boiled; potato irish boiled; potato, sweet, white peeled and cooked; yam, water, peeled, raw; yam water, peeled, grated "Ojojo".

3.4 Proximate Composition of Legumes and Legume Products

		Waste g	Moisture %	KJ g	Kcal g	Protein g	Fat		Carbohydrates				Alcohol g	Ash g
							Total g	Chol	Total g	Mono g	Poly g	Fibre g		
1.	Cowpea, blackeyed pea, dried	-	11	1430	342	23.1	1.4	-	61	-	-	4.8	-	3.3
2.	Cowpea, blackeyed pea, cooked	-	68	598	143	6.2	5.7	-	18	-	-	1.2	-	2.0
3.	Cowpea, Vigna Spp, young green pods	-	89	163	39	3.7	0.6	-	5	-	-	1.2	-	0.8
4.	Cowpea, Vigna Spp, mature pods, dried	-	11	1413	338	22.5	1.4	-	61	7.0	50.0	54	-	3.7

5.	Cowpea, Vigna Spp, whole meal	-	12	1584	379	24.9	1.6	-	66	-	-	3.0	-	4.2
6.	Cowpea, Vigna Spp, whole bean boiled (Ewa)	-	51	2475	592	24.6	2.1	-	66	-	-	3.0	-	3.2
7.	Cowpea, Vigna Spp, bean cake (Akara)	-	36	2533	606	26.3	27.3	-	38	-	-	2.9	0	5.1
8.	Cowpea, Vigna Spp, steamed cake (moin moin)	-	39	2558	612	24.0	12.0	-	57	-	-	2.4	-	2.9
9.	Cowpea, Vigna Spp, Steam paste (Ekur	-	69	2508	600	22.6	-	-	-	-	-	-	-	-

u)

10.	Cowpea, Vigna Spp, Soup (Gbegiri)	-	73	2671	639	26.8	21.2	-	43	-	-	2.4	-	5.1
11.	Lima bean, raw	0	11	1446	346	91.8	1.3	-	65	-	-	-	-	3.0
12.	Pigeon Pea, whole	-	10	1442	345	19.5	1.3	0	65	7.0	51.0	7.3	0	3.8
13.	Pigeon Pea, flour	0	5	1467	351	22.4	2.6	-	59	-	-	3.8	-	5.8
14.	Soyabean seed, dried	-	10	1693	405	33.7	17.9	0	34	0	29.0	4.7	0	5.0

Source: Oguntona and Akinyede, (1995).

Legumes include cowpea, blackeyed pea dried; cowpea, blackeyed pea cooked; cowpea vigna spp, mature pods dried; cowpea, vigna spp, whole meal; cowpea vigna spp peeled; cowpea vigna spp, whole boiled "Ewa"; cowpea vigna spp bean cake "Akara"; cowpea vigna spp. steamed cake "Moinmoin" and cowpea vigna spp. steamed paste "Ekuru". Others include lima beans raw; mesquite african seeds, whole dried; pigeon pea whole; pigeon pea flour; and soya bean seed dried.

3.5 Proximate Composition of Nuts and Seeds

		Waste g	Moisture %	KJ g	Kcal g	Protein g	Fat		Carbohydrates				Alcohol g	Ash g
							Total g	Chol	Total g	Mono g	Poly g	Fibre g		
1.	"Amusa"-nut, seed, dried	-	8	1751	419	28.7	18.3	-	41	-	-	2.8	-	4.0
2.	Bambara groundnut, fresh, raw	25	8	1442	358	21.1	6.5	-	53	-	-	5.1	-	3.8
3.	Benni seed, dried, raw	-	5	2432	595	17.9	48.4	-	22	-	-	4.5	-	6.2
4.	Benni seed, dehuled, roasted	-	3	2592	573	17.6	46.5	-	21	-	-	8.9	-	3.4
5	Cashew	-	8	22	54	17.	43	-	29	-	-	1.	-	2.

.	nut, dried, raw			65	2	4	.4				4		4
6.	Cashew nut, roasted	-	6	2299	550	18.6	43.7	-	29	-	-	2.4	-	2.5
7.	Coconut, mature kernel, fresh	30	42	1622	351	3.2	36.0	-	4	3.7	-	13.6	0	1.0
8.	Groundnut, fresh, raw	31	5	2364	570	24.3	49.0	-	9	3.1	5.5	8.1	-	2.5
9.	Groundnut, cooked	-	45	982	235	16.8	8.3	-	26	-	-	6.1	-	4.8
10.	Groundnut, dried, roasted	-	2	2487	595	23.2	50.9	-	22	-	-	3.2	-	2.4
11	Groundnut,	-	5	-	-	48.6	22.9	-	19	-	-	-	-	4.8

.	roasted, ground, fried "Kulikuki"														
12.	Kolanut K. nitida, fresh, raw	-	-	-	-	-	18.8	2.0	-	-	-	5.1	-	5.8	
13.	Melon seed, dried, without shell	25	5	2370	567	28.4	52	-	8	-	-	2.7	-	3.6	
14.	Melon seed, roasted	-	5	2429	581	27.1	50.3	-	16	-	-	2.3	-	2.7	

Source: Oguntona and Akinyede, (1995).

Nuts and seed include walnut "Awusa"; bambara groundnut, fresh, raw: beeniseed dehulled, roasted; beeniseed, dried, raw; cashew nut dried, raw; cashew nut roasted,; coconut, mature kernel, fresh; groundnut fresh, raw; groundnut cooked, groundnut dried and roasted; groundnut, roasted, ground , fried "Kulikuli"; Kolanut Kinitida fresh, raw; melon seed dried without shell; and melon seed roasted and fried "robo".

3.6 Proximate Composition of Fruits

W	Mois	KJ	K	Pr					Alc	A
ast	ture		e	ote					oh	s

		e g	%	g	al g	in g	Fat		Carbohydrates				ol g	h g
							Total g	Chol	Total g	Mono g	Poly g	Fibre g		
1.	Banana, ripe, peeled	37	70	1605	384	4.2	0.5	0	91	-	-	0.1	0	4.5
2.	Banana, unripe, peeled	-	75	1639	392	3.6	1.6	-	91	86	34.0	0.8	-	3.4
3.	Bush mango (African) pulp ripe	-	81	255	61	0.9	0.2	-	16	-	0.2	0.4	-	1.6
4.	Cashew, fruit, pulp	-	86	222	53	1.0	0.7	-	12	-	-	0.6	-	0.4
5.	Citrus, orange/tangerine, ripe	25	88	185	44	0.6	0.4	-	10	9.0	1.0	0.6	0	0.5
6.	Citrus, grapes fruit/shaddock	49	90	142	34	0.8	0.1	0.1	9	7.0	1.0	0.6	0	0.5
7.	Citrus, lemon/li	41	90	16	40	0.6	0.8	0	8	5.0	3.0	0.7	0	0.4

	me fruit			5										
8.	Dates, dried	31	17	1225	293	2.7	0.6	0	78	7.0	4.0	3.9	0	1.9
9.	Guava, ripe whole	19	82	675	64	1.1	0.4	-	16	-	-	5.3	0	0.6
10.	Mango, ripe, peeled	34	83	253	59	0.5	0.0	0	15	15.3	0	1.5	-	0.5
11.	Pawpaw, ripe, fruit	46	85	134	32	4.1	0.6	-	9	6.4	1.0	6.0	-	3.9
12.	Pineapple peeled, pulp	47	84	194	46	0.5	0.0	-	12	11.6	-	1.2	-	-
13.	Tamarind, fruit, dried	-	19	13259	325	8.8	2.5	-	67	41.2	0.6	2.2	-	2.9
14.	Water melon	45	94	92	22	0.5	0.1	-	5	-	-	0.4	-	0.3

Source: Oguntona and Akinyede, **(**1995).

Among fruits are banana, ripe, peeled; Banana unripe peeled; bush mango (African) pulp, ripe, cashew fruit pulp; citrus orange/tangerine, ripe; citrus lemon/Lime fruit; Dates dried; Guava, ripe whole; Mango ripe peeled; Pawpaw ripe, fruit: Pineapple, pulp; and Water melon.

3.7 Proximate Composition of Meals

		Waste g	Moisture %	KJ g	Kcal g	Protein g	Fat		Carbohydrates				Alcohol g	Ash g
							Total g	Chol	Total g	Mono g	Poly g	Fibre g		
1.	Amala + Ewedu	-	70	1722	412	17.6	4.4	-	76	-	-	1.5	-	1.1
2.	Beans and Bread	-	-	2738	655	18.4	4.8	-	-	-	-	2.8	-	2.5
3.	Eba and Okoro Soup	-	75	1977	437	9.9	10.0	-	72.0	-	-	3.5	-	4.6
4.	Foodoo + Okro SOup	-	-	2876	688	8.5	4.7	-	-	-	-	1.9	-	1.3
5.	Jollof Rice	-	41	1985	475	46.5	20.5	-	26	-	-	2.8	-	3.9
6	Lafun +	-	-	25	59	8.5	6.	-	-	-	-	2.	-	2.

.	Ewedu + Meat Stew			04	9		7					1		2
7.	Maize + Beans (Adalu)	-	-	2738	655	18.6	9.1	-	-	-	-	3.9	-	3.4
8.	Pounded yam + Afia Efere (Plain Soup)	-	75	1630	390	11.3	6.6	-	77	-	-	-	-	5.0
9.	Rice and Beans	-	63	2211	529	12.3	13.2	-	68	-	-	2.7	-	3.9
10.	Rice and Stew	-	-	2847	681	11.6	8.4	-	-	-	-	0.4	-	3.0
11.	Tuwo and Da	-	76	1747	418	20.8	4.2	-	74	-	-	-	-	0.4

	wa														
12.	Yam + Bean + Stew	-	-	2220	531	13.6	4.1	-	-	-	-	2.0	-	3.2
13.	Yam Pudding	-	73	2232	334	4.4	23.6	-	62	-	-	7.0	-	3.3
14.	Yam + Stew	-	-	2546	609	4.9	5.4	-	-	-	-	0.8	-	1.2

Source: Oguntona and Akinyede, (1995).

African meals common to West Africa especially Nigeria include "Amala" (yam or plantain flour) made into meals eaten with stew, okro or "ewedu"; Beans and Breas, Benas in stew, "Eba" (Cassava fermented into "gari" made into meals) with Stew "Ewedu"; Foofoo (fufu) with stew, okro or "ewedu", Jollof Rice; fried rice plus stew plus meat/fish/chicken; pounded yam plus meat/fish or assorted meat.

3.8 Mineral and Vitamin Content of Fruits and Vegetables

		Waste g	Moisture %	KJ g	Kcal g	Protein g	Fat		Carbohydrates				Alcohol g	Ash g
							Total g	Chol	Total g	Mono g	Poly g	Fibre g		
1	Banana,	37	70	1	3	4.2	0.	0	91	-	-	0.	0	4.

.	ripe, peeled			605	84		5					1		5
2.	Banana, unripe, peeled	-	75	1639	392	3.6	1.6	-	91	8.6	34.0	0.8	-	3.4
3.	Bush mango (African) pulp ripe	-	81	255	61	0.9	0.2	-	16	-	0.2	0.4	-	1.6
4.	Cashew nut, fruit, pulp	-	86	222	53	1.0	0.7	-	12	-	-	0.6	-	0.4
5.	Citrus, orange/tangerine, ripe	25	88	285	44	0.6	0.4	0.1	10	9.0	1.0	0.6	0	0.5
6.	Guava, ripe, whole	19	82	675	64	1.1	0.4	0	16	-	-	5.3	0	0.6
7.	Pawpaw, ripe, fruit	46	85	134	32	4.1	0.6	-	9	6.4	1.0	0.6	-	3.9
8.	Pineapple, peeled, pulp	47	84	194	46	0.5	0.0	-	12	11.6	0	1.2	-	-
9	Tamarind, fruit,	-	19	13	32	8.8	2.	-	67	41	0.	2.	-	2.

.	dried			59	5		5			.2	6	2		9
10.	Water Melon	45	94	92	22	0.5	0.1	-	5	-	-	0.4	-	0.3
11.	Amaranth leaves, cooked	506	1.7	62	-	-	0	1700	60	-	-	-	-	34
12.	Bitter leaf, dried	1.5	5.5	536	-	-	-	-	-	-	-	-	-	20
13.	Carrot, fresh	35	0.7	38	2500	49	-	5480	0.04	0.25	0	0.6	8	8.0
14.	Mushroom	20	1.5	10000	4700	9	0	0	0.1	0.4	0.1	0	4.0	2.3

Source: Oguntona and Akinyede, (1995).

This group includes Banana ripe, peeled; Banana unripe peeled, Bush mango Cashew, fruit pulp; Citrus and Orange/Tangerine ripe. Others are Guava, ripe, whole; Pawpaw, ripe fruit; Pineapple, peeled pulp; Tamarind, fruit, dried and Water melon. Among the vegetables are Bitter-leaf, dried; Carrot fresh; and mushroom.

3.9 Amino Acid Contents of Meat Poultry and Eggs

Essential Amino Acids

N g	T otal mg	T otal mg	C ys mg	I le mg	L eu mg	L ys mg	M et mg	P he mg	T hr mg	T yr mg	T rp mg	V al mg	A la mg	A rg mg	A sp mg	G lu mg	C ly mg	H is mg	P ro mg	S er mg

				g																	
1.	Beef, moderate fat	-	615 0	268 0	800	300 0	460 0	530 0	160	270 0	220 0	270 0	700	320 0	380 0	400 0	560 0	102 00	330 0	200 0	320 0	160
2.	Egg, Chicken, raw	2.0	123 20	559 0	220 0	690 0	102 00	770 0	630 0	630 0	490 0	220 0	670 0	750 0	132 00	148 00	370 0	300 00	390 0	470 0	970 0	930
3.	Egg, Guinea fowl, raw	-	624 5	305 7	143	314	578	431	252	294	279	225	121	420 0	339	387	671	752	184	129	281	445
4.	Mutton, moderate fat	2.7	162 05	747 5	307	933	1395	1580	598	764	375	212	1028	1300	1446	2320	794	454	441	598	770	870
5.	Offal	-	62	29	10	33	57	54	14	29	29	21	80	65	39	40	53	95	38	16	22	33

	s, heart		60	00	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0
6.	Offals, intestine cattle	-	-	-	121	959	1007	1411	611	529	626	492	-	701	-	132	-	-	-	-	369	-
7.	Offals, liver	-	5850	2740	900	2700	4900	5300	1500	3100	2700	1900	800	3600	3300	5400	7600	3100	2300	3300	3200	2900
8.	Offals, tongue boiled	-	6050	2640	900	2900	4400	6600	1100	2200	2600	1900	800	3000	3300	3700	5400	9800	3500	2500	3300	2600
9.	Offals, tripe dressed	-	6450	2480	800	2500	4200	5000	1500	2400	2700	1800	800	3100	4200	4400	5300	9400	9500	1500	5300	3100

10.	Pork, moderate fat	1.90	1496	5203	133	608	897	961	496	583	426	162	654	756	1060	1718	696	391	321	542	496	616
11.	Poultry chicken	3.2	198000	8780	2600	590	1540	1840	920	550	720	230	180	1280	1870	3380	1020	620	490	850	820	980
12.	Rabbit, stewed with bone	-	6240	2770	80	310	480	550	170	290	270	230	70	320	380	4000	600	1030	320	160	320	240
13.	Snail, dried	-	-	-	-	384	742	725	104	314	410	216	240	474	771	387	1202	2154	127	-	1843	5022
14.	Termites, dr	-	-	-	187	511	783	542	75	438	275	302	143	744	900	694	1045	885	393	514	-	119

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Source: Oguntona and Akinyede, (1995).

Beef with moderate fat; Chicken eggs; Guinea fowl eggs; Mutton; Offals; Pork with moderate fat; Chicken; Rabbit; Snail and Termites.

4.0 Conclusion

The Composition of Nigerian and African foods is very rich and adequate in terms of macro nutrients (Carbohydrates, Proteins and Fats) and micro nutrients vitamins and Minerals.

5.0 Summary

In this unit we have learnt that:

- Nigerian and African foods are very rich in the supply of energy rich foods mainly as Roots and Tubers.
- The micro nutrients of Vitamins and Minerals are abundant in fruits and vegetables.
- Protein for body growth and repairs are supplied by animals and fish products.
- Vegetables oils in form of palm oil, groundnut oil and corn oil supply the fat and the fatty acids.

Self-Assessment Exercise

List the common foods in the Nigerian diet that will favour:

i. High Energy
ii. High Protein
iii. High Fats

6.0 Self-Assessment Exercise

1. List nutrient composition of some Nigerian food.
2. Discuss two of the above listed.

7.0 References/Further Reading

Aiyeleye F.B. and Eleyinmi A.F. (1997). Improved Traditional Processing Techniques for Selected Tropical Food Commodities. FADCOL Educational Press, Akure, Ondo State, Nigeria.

Unit 2 Processing of Specific Food Commodities I: Roots, Tubers, Cereals and Legumes

1.0 Introduction

In a developing country like ours, the need for improved preparation, processing, preservation and storage techniques as a way of enhancing demand for indigenous, locally consumed foods, coupled with increased application of food science and technology not only to boost our dwindling agricultural production, but also to ensure that the seasonal foods harvested are adequately preserved and/or kept under good storage conditions, cannot be over-emphasized. This practice has brought wealth and prosperity to many nations and has greatly contributed to the raising of the standard of living in the industrialized countries of the world.

2.0 Objectives

By the end of this unit, you should be able to discuss the examples of:

- tubers (yam, cassava) that are processed by dehydration to make flours
- cereals and legumes that are also dehydrated and milled to flour to produce new food
- the fermentation of maize and African locust bean to make new flavoured foods.

3.0 Main Content

3.1 Processing of Specific Food Commodities in Nigeria

3.1.1 Root and Tuber Crops

Roots and tuber crops are agricultural products which grow beneath the soil. These include Yam (*Dioscorea sp*), Cassava (*Manihot sp)*, Sweet potato (*Ipomoea batatas*) and Cocoyam. They represent the most important source of energy in the diet of the tropical man. They have very high amounts of carbohydrates and trace amounts (if any) of the other major food groups. Thus, they are often taken with other food materials that will provide fats, proteins and other essential nutrients. Sweet potato and cocoyam are often consumed without processing. Major traditional food products of importance are obtained from yam and cassava.

3.1.1.1 Yam

Yams make up the genus *Dioscorea* of the family Dioscoreaceae. The water yam is classified as *Dioscorea alata,* the Chinese yam, or Chinese potato, as *Dioscorea batatas,* the air potato as *Dioscorea bulbifera,* the elephant's foot as *Dioscorea elephantipes,* and cush cush, or yampi, as *Dioscorea trifida.* Yams are good sources of the chemical diosgenin, a precursor of progesterone, cortisone, and other medically important steroids. Yam is the common name for any of several members of a genus of perennial herbs. Many varieties occur within these species, and the resulting yams may grow up to 2.4 m (8 ft) long and weigh up to 45 kg (100 lb) with brown or black skin and flesh that is white, purple, or red. Yams have been domesticated independently in many different parts of the world for their edible tubers.

Yams are a valuable source of carbohydrates to the people of Nigeria and indeed of West Africa. The most economically important species grown in Nigeria are white yam (*Dioscorea rotundata* Poir.), water yam (*Dioscorea alata* L) and yellow yam (*Dioscorea cayenensis Lam*.). Yams are grown in fairly high rainfall areas with a distinct dry season of not more than five months and a rainy season of not less than five months grown mostly in middle belt areas to the southern parts of Nigeria.

The usual method of propagation is to use the crowns of the large tuberous root or to plant whole small tubers. The climbing vines are supported on stakes or on a trellis. The plants are spaced 30 to 60 cm (12 to 24 in) apart in rows. The roots are harvested after they reach a suitable size and can be stored for several months at temperatures of 12 -15 ° C (54 - 58 °F).

Traditionally yams are processed into several products for immediate consumption in Nigeria. They are often eaten as boiled yam, roasted or fried yam (*Dundu*), grated and fried balls (*Ojojo*) pounded yam (*Iyan*) and yam flour (Elubo). The only traditional method for processing yam for storage is to process it into yam flour called "Elubo" in Nigeria and "Kokonte" in Ghana.

3.1.1.2 Yam Flour (Elubo)

"Elubo" is a dehydrated milled product obtained from yam of the Dioscorea species. It is a smooth brown powder, and being a wholly yam based product, it is a rich source of carbohydrates. Elubo is common among the Yoruba speaking people of Nigeria. Elubo is now gradually increasing in popularity among groups where "amala" has never been a staple food. This may be due to its the ease of production, its shelf stability and a convenient way of adding value to tubers mechanically injured (i.e. cut, bruised or damaged tubers) during harvesting. These damaged tubers generally have short keeping qualities. Elubo is prepared by reconstituting in boiling water with continuous stirring until a stiff gel of the desired consistency (called *Amala)* is obtained. It is commonly served for lunch and dinner with stew and vegetables. Elubo is commonly produced in large quantities in Oyo, Oshun, parts of Kwara and Kogi States. Apart from it being a good food, it is an economic item whose appeal cuts across all strata of social and economic class. Production of Elubo is now gradually increasing in popularity among ethnic groups where *amala* has never been a staple food.

Traditional Production of Elubo

Raw yams are peeled manually (usually from late evening), sliced (optional), washed and heated over a wood fire (parboil). The fire under the vessel is removed when the water is uncomfortably hot and left for about 8 – 13 hours after which they are removed and spread outside in the sun for drying. The dried pieces are then crushed, milled and sieved to obtain the characteristic smooth brown powder called Elubo.

Problems Associated with the Traditional Process

i. Low level of hygiene.
ii. During parboiling, some of the yam pieces become overcooked and such pieces are usually discarded.
iii. Drying time depends on the prevailing weather conditions. Under the best conditions, it takes 2 – 5 days.

iv. Since they are usually spread on bare floor, chances of contamination by extraneous matter and infestation by rodents and pests is quite high.
v. The operations involved vary from one place to the other, leading to inconsistencies in the products obtained from different locations.
vi. The finished product often contains pebbles, faecal matter, dead insects and their eggs among others.

3.1.1.3 Ojojo

"Ojojo" is a fried food product obtained from grated water yam (*Dioscorea alata*) It is a popular food product in the southern part of Nigeria, especially among the Yorubas where it can serve as a snack or main meal with "eko" (corn meal) as accompaniment. Of the various species of yam available, only water yam is suitable for use in its preparation.

Traditional Production of Ojojo

Water yam is peeled, cut into large pieces and manually grated yam is the mixed with chopped peppers, onions, tomatoes and salt after which it is made into small balls and fried in groundnut oil for about 5-8 minutes. The resulting product is Ojojo. It keeps for about three days (maximum) and is often refried as means of preservation.

Problems Associated with the Traditional Production Process

Grating: The manual grating operation is time consuming, labour intensive, and with a high risk of injury.

Browning: Water yam undergoes browning right from when it is peeled. It undergoes further browning during and after grating especially when it is not fried immediately.

Hygiene: The traditional processors generally have a low level of hygiene. This is probably a contributory factor to the short shelf-life of the commodity.

3.1.2 Cassava

Cassava is the common name for any of several related plants native to tropical regions in the Americas. It forms the staple diet of over 500 million people in the tropics. Cassava is the West Indian name; manioc, or mandioc, is the Brazilian name; and juca, or yucca, is used in other parts of South America. The plant grows in a bushy form, up to 2.4 m (8 ft) tall, with greenish-yellow flowers. The roots are up to 8 cm (3 in) thick and 91 cm (36 in) long. Manioc, or cassava, is widely cultivated as an important source of starch and staple food among many tropical peoples. It is one of the most important world food crops. Many varieties and closely related species contain the poison hydrocyanic acid, which can be removed only by cooking the root. A related species, *M. dulcis*, is sometimes grown as fodder for livestock.

There are two major species of cassava in Nigeria. These are the sweet cassava (*Manihot palmata*) and bitter cassava (*Manihot utilissima*) respectively. The bitter variety contains a poisonous bitter juice (hydrocyanic acid) which must be extracted before it is safe for consumption. Because the bitter species predominates in Nigeria, it undergoes rigorous processing to ensure that the cyanide content is reduced to harmless levels. Because the volatile poison can be destroyed by heat in the process of preparation, both varieties yield wholesome foods. Human consumption of fresh unprocessed roots has been linked with a number of chronic disorders, high occurrence of endemic goitre and various neurological

degenerative syndromes (particularly in malnourished populations) such as ataxic neuropathy and cretinism and occasionally, death due to the presence of toxic cyanogens.

The cyanogenic glycosides produce hydrocyanic acid (HCN) when the action of an endogenous enzyme, linamarase, is initiated by crushing or otherwise damaging the cellular structure of the plant. The cyanide in cassava exists as bound glucosides, cyanohydrins and free cyanide (HCN). The utilisation of cassava roots for both human and animal nutrition appears to be limited by the presence of these cyanogenic glycosides. As a result, the roots have to be processed by a wide range of traditional methods in order to reduce their toxicity and improve palatability.

Large tuberous cassava roots are processed into cassava flour, or tapioca, or they may be fermented into an alcoholic beverage. Cassava products are also used as laundry starches and fabric sizings and in the manufacture of explosives and glues. The root in powder form is used to prepare *farinha,* a meal used to make thin cakes sometimes called cassava bread. The starch of cassava yields a product called Brazilian arrowroot. In Florida, where sweet cassava is grown, the roots are eaten as food, fed to stock, or used in the manufacture of starch and glucose.

In Nigeria, about 70% of cassava produced is channeled into *gari* production. Other products commonly obtained from cassava processing are *fufu* and *lafun*.

3.1.2.1 Garri

"Garri" is a fermented, gelatinous granular flour obtained from cassava *Manihot* spp). It is one of Nigeria's most popular staple food and is reputed to contribute as much as 60% of the total calorie intake of the population. Being a source of cheap carbohydrate for many Nigerians it is consumed sometimes twice a day, either it's intact from with sugar, groundnut or salt or further transformed into garri meal (eba) and eaten with vegetable or any mucilaginous soups. Because it is a ready-to-eat and easy to prepare food item, its acceptability cuts across all economic and social strata. The popularity of garri a major staple food is at a peak among the Yoruba and Ibo tribes of Nigeria where it is commonly served for lunch or dinner.

Traditional Production of Garri

Cassava is peeled, washed, rated into a watery pulp, poured into sacks, and allowed to ferment for about 2-4 days. The resulting pulp is sieved, roasted and spread out in an open area to cool. Gari is then bagged in sacks of various sizes till it is needed for commerce or consumption.

Problems Associated with Traditional Production

Nature of Cassava: No emphasis is placed on the use of freshly harvested cassava tubers. The result is that the cassava often used have been harvested for 2-3 days before processing starts.

Peeling and Washing: Cassava is peeled manually – a process which takes considerable time. Rather than continue processing immediately, the peeled cassava is often left overnight resulting in browning of the tubers. Washing of the tubers is usually carried out with water obtained from streams. To the traditional processors, the nature, the type and source of water is not a critical factor.

Grating: The grating operation is carried out using outstretched, perforated tin cans the efficiency of which is a function of the degree of perforation and applied pressure. This process apart from being crude, increases the chances of accidental bruising of hand, especially the fingers.

Roasting: More often than not, the gari is not allowed to dry completely, rather it is half dried and spread in the sun thus sacrificing quality in the name of profit maximisation.

Dewatering: This is done by placing heavy stones on the grated mash packaged in jute bags and sackcloths. This process is not only unhygienic, it also result in accumulation of sand particles inside the final product.

3.1.2.2 Fufu

"Fufu" is wholly carbohydrate based food material obtained from cassava. It is commonly eaten in the core East and Southwest parts of the country. The type of soup that goes with it depends on the locality in question. It has a generally wide acceptance as reflected in the fact that it can serve either as a breakfast, lunch or dinner meal in fufu-eating areas of the country.

Traditional Production of Fufu

Raw cassava tubers are manually peeled (mostly by women) and soaked in a big clay pot for about 3-4 days. During this period, fermentation takes place. The fermented tubers are then crushed, sieved and allowed to settle (sedimentation). The sediment (wet fufu) is then packed in sacks and de-watered under heavy stones. The de-watered product is stored in sacks until it is needed for commerce or consumption.

Problems Associated with Traditional Production

The major shortcomings of the traditional process are its irritating and undesirable odour as well as its low shelf life. Furthermore, the basic tenets of hygiene are not observed.

3.1.2.3 Lafun

"Lafun" is wholly carbohydrate-based food material obtained from cassava. It is commonly eaten in the Western part of Nigeria as a lunch or dinner meal usually with vegetable in "egusi" soup. Its appeal however, cuts across all strata of economic life.

Traditional production of Lafun

Freshly harvested cassava tuber is peeled and soaked in water either in a pot or big container. After about three days, the soaked tubers is hand-crushed after which it is spread on the floor or a platform for solar drying. The drying process takes three or more days depending on the environmental conditions. When it is sufficiently dry, it is then milled and sieved to obtain lafun. It is then stored in sacks of jute bags till it is needed. In addition lafun may be stored or packed in nylon containers or baskets.

Problems of Traditional Production

Drying Process: The sun-drying process is inefficient, time consuming and erratic. This becomes significant where weather conditions fluctuate. When improperly dried, the flour cakes and is susceptible to yeast and mould attack.

Hygiene: Very little consideration is given to hygiene. This is evidence in the grooming of the processors and the dirtiness of the floor where the crushed tubers are spread.

Process Time: The process is time consuming. So much time is lost during the manual peeling process as well as during the sun-drying operation.

3.1.3 Sweet Potato

The sweet potato belongs to the family *Convolvulaceae*. It is classified as *Ipomoea batatas*. The species called wild sweet-potato vine, manroot, or man-of-the-earth is classified as *Ipomoea pandurata*. The plant, which is native to tropical America, is cultivated on sandy or loamy soils throughout many warm regions of the world, and exists as an important food staple in a number of countries. It is planted primarily for its thick, edible roots, called sweet potatoes. Two main types are commonly cultivated: a dry, mealy type, and a soft, light-to-deep-yellow, moist-fleshed type. The species often called wild sweet-potato vine, manroot, or man-of-the-earth is not edible, but is cultivated as an ornamental vine.

The sweet potato yields an important starch, which is used commercially for sizing textiles and papers, for the manufacture of adhesives, and in laundries. The pink and yellow varieties are rich in carotene, the precursor of vitamin A.

3.2 Cereal and Legumes

In the topics, the common cereals are maize, sorghum, rice, and millet. They are good sources of carbohydrates, vitamins and minerals. Apart from being articles of commerce, they can be processed into a wide range of food items and snacks. This characteristic feature makes cereals indispensable in the diet of the tropical man.

Legumes refer to the group of edible plant proteins which belong to the family leguminosae. They are major type of plants that supply the body with proteins. In this category are pigeon pea (*Cajanus canjan*), lima bean (*Phaseolus lunatus*), cowpea (*Vigne unguiculata*) and groundnut (*Arachis hypogea*). Legumes play very important roles in the diet of people in the tropics. Apart from being good sources of proteins, they supply important minerals and vitamins essential for the normal functioning of metabolic activities.

3.2.1 Kokoro

"Kokoro" is a snack common among the Egbas of Yorubaland. It is often taken as light refreshment and can be used in entertaining guests with soft drinks. There are two main types of kokoro. The white and the brown type for the purpose of the text, the brown kokoro will be studied, being the most popular form in which kokoro is consumed.

Traditional Production of Kokoro

Maize is washed, dried and milled to obtain maize flour. The flour is pregelatinized during which sugar and salt are added to taste. The resulting dough is cooled, sprinkled with maize flour and molded into desired shapes and sizes. It is then fried in vegetable oil, drained and cooled to obtain the ready-to-eat snack, kokoro. The product is usually covered with leaves and packaged in thin polyethylene nylons. The main method of preservation is by refrying in oil.

Problems of Traditional Production

Shelf life: Freshly prepared kokoro keeps for 4 – 5 days after which it is no longer suitable for consumption.

Preservation technique: The method of preservation often employed predisposed the commodity to oxidative rancidity and development of burnt flavours.

Raw materials quality: No consideration is given to the quality of maize, sugar and oil used.

Hygiene: The level of hygiene of the processors as well as the processing environment is generally low.

3.2.2 "Ogi" or Pap

"Ogi" (also called "Akamu") is fermented product obtained from maize or guinea corn. It is a staple cereal meal of the Yorubas in Nigeria and is the first major food given to babies at weaning. It is commonly eaten with "Akara" (Bean cake) or "Moin-moin" (Bean meal). Ogi can also be consumed in the form of "Agidi" or "Eko" (a solid cooked form of Ogi). It is a wholly carbohydrate based food and has been implicated in the incidence of kwashiorkor in children fed solely with it. The wet ogi is normally reconstituted with hot water to form a paste which is the form in which it is consumed.

Traditional Production of Ogi

Raw maize grains are steeped in warm or cold water for 2-3 days. It is the wet-milled and sieved. The filtrate is allowed to settle and the water drained off. The resulting product is Ogi. It is usually packed in leaves or stored under water until it is needed.

Problems of Traditional Processing

The product is susceptible to microbial spoilage due to its high moisture content and low hygiene ratings. The shelf life is considerably low. Storage under water encourages post-processing fermentation which leads to sources over a period of time. It is of poor nutritional status being a wholly carbohydrate based meal.

3.2.3 "Tuwo"

"Tuwo" is a corn-based meal made from milled corn. It is produced either from white or yellow corn although yellow corn is preferred. It is a wholly carbohydrate-based meal, commonly eaten as a lunch or dinner with "Gbegiri" (bean stew). Tuwo can also be produced from rice- a delicacy popular among the Hausas and the Fulanis. When produced

from rice, it is referred to as Tuwo-shinkafi. The corn cased Tuwo would be the focus of this treatise.

Traditional Production of "Tuwo"

The epidermal covering of freshly harvested maize cob is manually removed. The grains are then removed manually and sun-dried for 2-4 weeks (duration depends largely on the prevailing environmental conditions). When it is sufficiently dry, it is winnowed, milled and bagged till it is needed for consumption.

Problems of Traditional Processing

- The sun-dried grains are susceptible to attack from rodents, birds and other corn eating animals. This greatly reduces the quality and quantity of the grains and by extension, the quality of the flour.
- Heavy stony particles are usually not removed during winnowing. When milled with the grains, the flour becomes grainy the result is low quality product.
- Its shelf life is considerably short. This could be attributed to the high moisture content of the commodity (a direct consequence of inefficient drying) and the oxidation of the oil content of the germ.
- The flour is subject to infestation by micro-organisms like *bacillus aureus, Clostridium welchi, Salmonella, etc.* They could be transferred from animals to the grains during the drying process, birds, dusts and soil. These micro-organisms are of public health significance.

3.2.4 "Donkwa"

"Donkwa" is a corn and groundnut based snack common among the Hausa of Nigeria. It is referred to as "Tanfin" among the Yoruba; it is often used as light refreshment with or without soft drinks as accompaniment. The wide acceptance the snack receives is not unconnected with its sweet taste and pleasant aroma.

Traditional Production of Donkwa

Groundnuts and corn are roasted dry and milled to obtain a fine powder. Ingredients referred to among the Yoruba as "atare" "iyere" "conofuru" "eso oganwo" and dry pepper are milled and mixed with the corn-groundnut flour. Sugar and salt are added, mixed homogeneously, and then pounded in a mortar. The mixture is then moulded into desired shapes and sizes to obtain donkwa in the ready-to-eat form.

Problems of Traditional Production

Nature of raw materials: No emphasis is placed on the use of good quality corn and groundnut. In addition, the ingredients added are not obtained under sanitary conditions. This is all the more important because the commodity is in the ready-to-eat state.

Oxidation: Oil is released during the pounding operation. This oil is susceptible to oxidation leading to rancidity and development of off-flavours

Packaging and Storage: The commodity has no packaging material. They are simply displayed in glass shelves, aluminium pans and bowls. The implication of this is their increased susceptibility to pest and rodent attack.

Hygiene: Traditional processors give little or no regard to the tenets of hygiene. Thus, the prospect of cross-contamination is quite high. The unhygienic conditions employed can equally be source of food borne infection and intoxications.

3.2.5 "Robo"

"Robo" is a locally prepared snack common among the Yorubas is Nigeria. It is liked for its sweet and delicious taste. Its main raw materials "Egusi" (Melon – *Citrullis vulgaris*) and pepper (*Capsicum* spp). It comes in a wide range of shapes and figures. It is commonly eaten as a snack or as a main meal in conjunction with "Ogi" or "Gari".

Traditional Production of Robo

Raw melon seed is harvested and sun dried till the husk is sufficiently strong to be removed. It is then shelled manually and ground on a millstone to obtain a thick paste. At this stage onion (*Allum cepa*) is ground and homogeneously mashed with the melon paste. The resulting slurry is hand squeezed, mixed with wet milled pepper and salt and then moulded to the desired shapes and sizes. After shaping, the resulting product is fried in melon oil (previously extracted) until it turns brown. It is then cooled and packaged in small nylon packs.

Problems of Traditional Processing

- The sun-drying process is time consuming (it depends on the prevailing weather conditions) and exposes the seed to attack from pests and rodent.
- The shelling process is done manually, usually by woman. This process, apart from being slow, leaves little room for proper hygiene.
- Grinding on a millstone is time-consuming and chance of cross-contamination is quite high.
- Manual mixing, mashing, and moulding expose the product to contamination from the processors. Where personal hygiene is given very little consideration, it could pose a serious health risk to consumers.
- Packaging is done in thin transparent nylon packs. This exposes the commodity to both oxidative and hydrolytic rancidity, which in turn, reduces its appeal and shelf life.
- Storage is by re-frying in melon oil after two or three days. This makes the commodity more susceptible to rancidity and leads to the development of burnt flavours.

3.2.6 Ekuru

The traditional name of bean meal is "Ekuru". Being a wholly cowpea-based food item it is quite rich in essential amino acids. Locally, it is consumed as a lunch or dinner meal with "eko" (fermented maize gruel) as accompaniment. It is one; of the popular forms into which beans is processed among the Yoruba's of Nigeria.

Traditional Production

Beans are soaked in water for 2-3 hours. It is then dehulled and milled using small quantities of water to obtain a slurry of the right consistency. The resulting slurry is stirred, carefully wrapped in leaves, and steamed for about 45 minutes. The resulting product – ekuru – is ready to be eaten. Traditional storage is by steaming at regular intervals, usually, every other day.

Problems Associated with the Traditional Method of Preparing Ekuru

Some of problem associated with the traditional production process are enumerated below:

- It is time consuming. So much time is spent during soaking, decoating and milling (on a milling-stone).
- It cannot last for a very long time after preparation.
- Significant deleterious organoleptic and nutritional changes do take place after a couple of days. This is due, in part, to interaction (chemical or otherwise) between the leaves and the food item and the activities of micro-organisms.

3.2.7 Groundnut Cake

This is a wholly groundnut based snack commonly referred to as "kulikuli", among the Yoruba's of Nigeria. It is either eaten alone, or more commonly with "gari". Its appeal cuts across the country. The wide acceptance it receives is due largely to its sweet taste.

Traditional Production of Kulikuli

Freshly harvested groundnut is sundried, sorted, immersed in brine for few minutes, drained and sundried. The dried nuts are then roasted in a heated sandfilled slay or iron pot and stirred continuously with a wooden spoon until a golden brown colour is obtained. The roasted grains are then cooled, dehulled winnowed, and pounded until it is sufficiently smooth. The resulting paste is kneaded and pressed (squeezed) to extract it oil. At this point, some ingredients like ground pepper and salt are added to taste. The groundnut meal is the shaped and fried in the previously extracted oil (groundnut oil) until the golden brown colour characteristic of the ready-to-eat kulikuli is obtained. The resulting cakes are cooled, and packed in open baskets.

Problems Associated with Traditional Production

- **Hygiene**: As with most other traditional products, very little attention is given to hygiene (both personal and environmental) by the processors.
- **Raw materials:** No attempt is made to sort out unwholesome and defective grains.
- **Winnowing**: The method employed is grossly inefficient as chaff, dirts and other extraneous matter still remain in the commodity.
- **Pounding**: The pounding process is energy, labour and time – consuming.
- **Packaging**: There is no standard packaging material (or method) for kulikuli. They are simply poured in sacks and open baskets until they are needed for commerce or consumption.

3.2.8 Iru

"Iru" is fermented African locust bean (*Parkia biglobosa*) It is one of the most important food condiment in the entire savannah region of West and Central Africa. Apart from its flavouring attribute, it contributes significantly to the intake of protein, essential fatty acids and B Vitamins, particularly riboflavin. It is also known as Dawadawa (Hausa land) and Ogiri – Igala (Ibo land). The popularity of the fermented beans as a major condiment necessitates a review of the traditional process with a view to enhancing its image, especially among the ever increasing urban populace who place more premium on hygienically produced food items.

Traditional Production of Iru

Locust beans are boiled for about an hour to soften the seed for removal. The hulls are removed, followed by washing and boiling for additional ten to twelve hours to soften the cotyledon. The cotyledons are allowed to undergo wild fermentation for about two to three days. During this period, the characteristics colour (brown) and odour (ammoniated) are developed. Iru is prepared in the solid non-mucilagenous form (woro) or in the marshy mucilaginous state (pete) for sale or consumption.

4.0 Conclusion

Food processing technology is widely applied to African foods to make convenient snacks and meals. For example, tubers are dehydrated into flours. Cereals are also treated in similar fashions. Also the process of fermentation is applied to African locust beans to make condiments.

5.0 Summary

In this unit we have learnt that:

- Tubers like yam are boiled, dried and turned into other products e.g. pounded yam and elubo.
- Similarly, cassava is grated after peeling, pressed and dried to make garri and other snacks
- Cereals can be fermented and dried to ogi and eko products
- Legumes are also processed. For example, groundnuts are toasted and ground to make kulikuli

Self-Assessment Exercise

Enumerate some of the difficulties of processing of African (i) tubers (ii) Cereals (iii) Legumes and Oilseeds into convenient foods.

6.0 Self-Assessment Exercise

1. How would you improve the shelf life of (a) Elubo (b) Fufu (c) Kokoro and (d) Robo?
2. Discuss the possible process line for the production of gari.

7.0 References/Further Reading

Aiyeleye F.B. and Eleyinmi A.F. (1997). Improved Traditional Processing Techniques for Selected Tropical Food Commodities. FADCOL Educational Press, Akure, Ondo State, Nigeria.

Unit 3 Processing of Specific Food Commodities II: Fruits, Vegetables, Milk, Meat and Fish

1.0 Introduction

In a developing country like ours, the need for improved preparation, processing, preservation and storage techniques as a way of enhancing demand for indigenous, locally consumed foods, coupled with increased application of food science and technology not only to boost our dwindling agricultural production, but also to ensure that the seasonal foods harvested are adequately preserved and/or kept under good storage conditions, cannot be over-emphasized. This practice has brought wealth and prosperity to many nations and has greatly contributed to the raising of the standard of living in the industrialized countries of the world.

2.0 Objectives

By the end of this unit, you should be able to discuss the processing of:

- fruits and vegetables locally
- alcoholic and non-alcoholic beverages from cereals
- milk products from milk
- meat and fish products.

3.0 Main Content

3.1 Processing of Various Traditional Produce

3.1.1 Fruits and Vegetables

3.1.1.1 Tomatoes

Tomatoes (*Lycopersicon esculentum*) are a circular red pigment fruit (vegetable belonging to the family of plants called Solanacae. It is rich in vitamins. A.B,C and minerals like Iron. Sodium, Potassium as well as trace amounts of carbohydrates and proteins. Tomatoes are commonly used in sauce, salad and they enhance the red colour of stew. Its major defect lies in its short shelflife due largely to its tender nature and high moisture content.

Traditional Processing of Tomatoes
Tomatoes have no traditional processing method. Rather they are stored in jute bags, baskets and leaves till they are needed for consumption or commerce.

Problems of Traditional Handling

Mechanical Damage
Storage in basket leads to bruises which, in turn leads to microbial proliferation, deterioration and spoilage. Storage in sacks leads to pressure build-up such that produce at the bottom gets crushed. The product is also subject to injury from improper handling during harvesting.

Shelf Life
The shelf life of mature ripe tomatoes is about 2-3 days. The result of this is a drop in its commercial value. The mature unripe fruits can hardly keep for 10-12 days in the absence of any form of preservation.

3.1.1.2 Green Leafy Vegetables

Green leafy vegetables grow abundantly during the rainy season in most parts of Nigeria. The availability of these vegetables during this period makes them an important inclusion in the diet of most people. During the dry season, however, these vegetables become scarce and expensive. The principles discussed below for bitter leaf applies to all edible green leafy vegetables. Debittering operation applies only to vegetables with bittering principles.

Traditional Processing of Bitter Leaf
The leaves are removed from the stalk for washing with subsequent shredding (optional). The leaves are rubbed between the palms in cold water (containing table salt, NaCl). Shredding – usually with knives and wooden table – is to reduce the leaves into small fragments. The shredded produce is either sun-dried or moulded (wet) into ball-like structures and kept till it is needed for consumption. Sun-drying – probably the oldest method of food preservation in developing countries for the drying of fruits and vegetables – involves spreading the products of the ground in an area that has been cleaned of leaves, stones, grass and dirt or they can be spread on mats.

The disadvantages of open-air sun drying are numerous. They are:

(i) The intermittent nature of solar energy throughout the day and at different times of the year.
(ii) The possible contamination of the food material by dirt and rodents.
(iii) The infestation of the food by insects.
(iv) The exposure to weather elements – such as rain and wind – which cause spoilage and losses.
(v) It is inefficient and will generally not lower moisture content below about 15%, which is too high for storage stability of many products.

To better utilize solar radiation as a source of energy for drying foods and foodstuffs, effective system have to be developed based on specific produce needs.

3.1.1.3 Palm Oil

Palm oil is a deep orange, viscous liquid obtained from the fruits of the palm tree. The palm tree is widely cultivated in the Western and Easter part of Nigeria due largely to the favourable weather conditions for their survival in these areas. It is an indispensable part of the Nigerian diet as it serves as a base material for a wide range of soups, gravies and other delicacies. It is also a good source of energy and fat soluble vitamins (A, D, E and K).

Local Extraction Process
Although the process involved vary from one locality to the other, the following unit operations show the major steps involved in the traditional extraction process.

Fruit Bunches

Separation of Fruits from Bunch

Separation from Calyx

Boiling

Separation of fruit from Nut

Boiling

Palm

Palm fruits (together with the calyx) is separated from the stalk. It is then packed in heaps covered with banana leaves and left for about three days before the fruit is separated from the calyx. The separated fruits are poured into a big drum and boiled for about four hours to soften the pericarp. It is then transferred into a wooden mortar or a cemented pit where it is crushed gently with pestle and pegs till a mixture of nuts and crushed pulp of even consistency is obtained. Floating oil is collected from the pit, transferred into a drum 1/3 full with water and heated continuously until the crude oil is sufficiently extracted. The crude oil - in its ready-to-use form. The oil is stored in earthenware pots, metallic drums an plastic kegs till it is needed for use.

Problems Associated with Local Extraction Process

1. Oxidation
The fruit is exposed and subjected to microbe-induced lipoxidation if left for about 3-4 days after harvest without processing. The process (lipoxidation) leads to hydrolyses of the oil with the subsequent production of undesirable free fatty acids.

2. Inconsistency in the Maturity and Degree of Ripeness of Fruits
When unripe fruits are used, oil of low quality and volume is obtained. On the other hand when over ripe fruits are used, the oil produced deteriorates rapidly and has high level of free fatty acids.

3. Hygiene
The level of hygiene on the part of the processors an processing environment is generally low. This increases chances of cross contamination.

4. Risk of Injury
The leg crushing exercise is generally unsafe. Apart from the risk of injury on a slippery floor, chances of microbial infestation are quite high especially if the state of health and hygiene of the labourers is poor.

5. Labour and Time requirement
The entire process is labour intensive and time-consuming.

6. Storage

The Storage system employed is grossly inefficient. The packaging material used range from earthenware pots to metallic plastic kegs.

- Earthenware pots predispose the oil to hydrolytic oxidation which leads to development of flavours and rancidity.
- Metallic can rust and become particles in the oil. The rust could also lead to rancidity.
- Plastic kegs might impart their characteristic odour on the oil when stored for a considerable period of time.

3.1.1.4 Dried Okra (Orunla)

"Orunla" is a product of the dehydration of okra pods (*Hibiscus esculentus*). The varieties mainly grown in Nigeria include long pod, green velvet pod, long green and lady finger. The harvest is done manually by snapping then off the stem when their tip are still tender and break with a snap. Orunla is very popular among the Yorubas. It is commonly made into soup with or without palm-oil, fish and other condiments and served with "Fufu", "Lafun", "Amala" or "Eba" where its mucilaginous property aids bolus movement in the oesophagus. At times, it is boiled fresh and served with rice.

Traditional Production of Orunla

Freshly harvested pods are sliced and spread on trays or flat surface for solar drying for about 3-5days (depending on atmospheric conditions). The dried okro is packed in that state or milled into powdery form before packaging (wrapping) in paper or thin nylon sachets.

Problems `of Traditional Processing

1. Apart from the many problems associated with the sun-drying process, there are major defects in the commodity due largely to the drying method employed? These include:

(i) Loss of Colour: The colour of the dried product is brown. In the fresh state it is green.
(ii) Loss of mucilaginous property.
(iii) Loss of nutrients, especially vitamin C.
(iv) The risk of microbial infection e. g. Bacillus cereus can be contacted from the soil or dust.

2. There is increased chance of skin irritation-induced by the spines on the skin of okra pods when large quantities are processed.

3.2 Alcoholic and Non-Alcoholic Beverages

3.2.1 "Sekete"

"Sekete" is a local wine obtained by the fermentation of plantain (*Musa paradisiaka*). Plantain is very common in the southern part of Nigeria and its colour ranges from complete green (unripe) to complete yellow (ripe) Being a wholly carbohydrate based crop makes it a good substrate for fermentation. Sekete is commonly served for entertainment and during certain traditional ceremonies and festivities. It is preferred for its taste and alcoholic content.

Traditional Production or Sekete
Mature ripe plantain is peeled cut into small sizes and soaked for fermentation to take place. Often times, this process (fermentation) is catalysed by the addition of palm wine sediments (containing the *Saccharomyces* yeast). After about five days the resulting liquor Sekete is filtered, filled into bottles and is ready to drink.

Problems of Traditional Processing

1. Hygiene
The level of hygiene among the traditional processors (mostly women and nursing mothers) is generally low. The poor hygiene and low level of cleanliness of the processing environment aggravates the low level of hygiene.

2. Water
The water often used for soaking is usually not of potable grade. It is obtained from streams and stagnant pools. This increases the chances of water borne infections and contaminations.

3. Fermentation
The fermentation process is wild. This result in a wine with different types of alcohols – many of which are not food grade. The only food grade alcohol is ethanol.

4. Shell life
The shelf life of the product is about two to three days. This is because the fermentation process still continues after bottling a situation which results in the depletion of the sugar base and development of an undesirable sour taste. Since there is really no effective method of storage, the over-fermented liquor is distilled to obtain "Ogogoro Local gin")

3.2.2 "Ogogoro"

The most widely accepted and cherished traditional alcoholic drink, especially in the southern part of Nigeria is the local gin, fondly referred to as "ogogoro". It is a product obtained by the fermentation of palmwine – a whitish sap obtained from the oil palm tree. Ogogoro finds use during ceremonies and festivities. Industrially, it is used as organic solvent and in the manufacture of certain drugs and chemicals.

Traditional Production of Ogogoro
Freshly tapped palmwine is collected, filled into a big container covered with a piece of cloth, and allowed to undergo fermentation for about 3 to 4 days. The fermented liquor is then distilled and ogogoro is collected through delivery tubes connected to the distillation apparatus. It is then filtered and filled into kegs and bottles.

Problems Associated with Traditional Production

1. Area of Fermentation

(i) Places where palm wine is kept for fermentation are filthy most times. This is unhygienic and leads to contamination of the wine.
(ii) Local producers rely wholly on the natural yeast in palm wine for fermentation. This makes the process time consuming and less profitable.

2. Area of Distillation
The heating of the fermented wine is done with naked flame and the smoke from the flame can contaminate the wine.

3. Area of Condensation
Locally, the method used in condensing the wine vapour is neither effective nor efficient and a reasonable amount of the wine is lost in the process.

4. Hygiene
The level of hygiene is generally low.

3.2.3 Burukutu

"Burukutu" originated from the Northern part of Nigeria, from the Hausas from where it spreads to other parts of the country, most especially the Southern and Western parts. It is produced from fermentation of cereals like maize, sorghum, millet, guinea corn, etc. This makes it rich in carbohydrates and therefore, it is a satisfying energy giving drink. It is creamy and dirty white in colour and highly alcoholic (28-40%). Non-alcoholic "Burukutu" is produced by skipping the fermentation operation. The cereal of choice is the sorghum specie. It is used to entertain visitors and during traditional festivals. Apart from being a ceremonial product, it is also produced for economic purposes. It is, infact, one of the best and popular local wines in Nigeria.

Traditional Production of Burukutu
"Burukutu" is produced in different ways, depending on the locality and the type of cereal used for the production. The following is one of the commonest methods frequently employed in the traditional production process. Guinea corn is washed, steeped for 24 hours and pitched into baskets to drain-off the water present. It is then allowed to germinate for about 4 to 5 days after which it is washed, milled (on a grinding stone) and mashed with starchy powder (from cassava tubers).

The mash is then filtered with pure white cloth. (Non alcoholic Burukutu is derived here by adding sugar to the filtrate). The filtrate is then allowed to ferment in a sack called "Apo-Idoho" for about 2-3 days. Wild yeast are often used to hasten the fermentation process.

The fermented liquor is then boiled for about 2 hours and allowed mature for a day. The wine is then ready-to-drink after maturation.

3.2.4 Kunnu

"Kunnu" is a millet based non-alcoholic beverage flavoured with spices. It is very popular among the Hausa's of Nigeria; however, its popularity in other parts of the country is fast on the increase. Kunnu is taken as refreshment and for its purported sedative (laxative) effect especially when served chilled.

Traditional Production of Kunnu
The major raw materials used are millet, guinea corn, ginger, spices and chillies. These materials are washed, soaked and milled. The resulting slurry is sieved and the filtrate allowed to sediment while the water atop is decanted off. 75% of the thick residue obtained is boiled with periodic addition of calculated amounts of water. The remaining 25% is then

mixed with the cooled residue and sieved to obtain the ready-to-drink Kunnu. Sugar, if desired, is added to taste. Kunnu has no traditional method of storage.

Problems of Traditional Production

1. Shelf Life

Its shell life is short. It can hardly stay for more than 2 days. After this period, it gets soured up. This can be attributed to uncontrolled fermentation taking place in the commodity.

2. Hygiene

The level of hygiene of the processors and processing environment is generally low. Chances of contamination and contracting food borne infection are higher. This is because kunnu is made up of 25% uncooked portion. Local processors are nursing mothers who tends babies during production.

3. Texture

The drink produced is often grainy. This may be attributed to improper or inadequate sieving.

4. Over Boiling

Oftentimes, the drink is over boiled. The result is the development of a flat, burnt flavour.

5. Addition of Ingredients

If other ingredients used are not properly selected, it influences negatively the taste and quality of the final product. The critical ones being ginger and chillies.

6. Quality Control

The quantities of ingredients vary with the different production centres. This is left entirely to the judgement of the processor, thus, kunnu tastes differently depending on the point of production.

3.2.5 "Pito"

"Pito" is a light-brown, sweet-sour beverage with fruity flavour obtained from malted maize and/or sorghum. It is a highly nutritious drink that has found place after meals, during ceremonies, festival and other social gatherings. Pito is reputed to be rich in minerals and certain B-Vitamins. Two types of pito are common, the alcoholic and non-alcoholic pito. The difference lies in the incorporation of fermentation step for alcoholic pito. This review will focus more attention on the alcoholic pito, being the more complex of the two.

Traditional Production of Pito

Maize or sorghum is steeped in water for 3-4 days, washed, milled and sieved to obtain a filtrate. The filtrate is allowed to sediment while the liquid atop is poured into a container where it undergoes fermentation for 2 – 3 days. Sugar is dehydrated, added into the fermenting liquor and boiled for several hours. The liquor is cooled and sugar is added to taste. The resulting product is the alcoholic pito. For non-alcoholic pito, fermentation step is omitted. Storage is in clay pots and large calabashes.

Problems of Traditional Production

1. Hygiene

The level of hygiene is generally low. Local processors (usually women) give little or no regard to personal hygiene not to mention hygienic food processing practices and environment.

2. Quality of grains
No attempt is made to ensure that the grins used are viable and wholesome.

3. Fermentation
The fermentation process is wild and uncontrolled. The result is a product with off-flavour and high levels of acetic acid.

4. Heating process
Heating is by firewood. This leaves no room for temperature regulation during mashing and dehydration of sugar. Wood smoke freely interferes with the food system and this could alter (affect) the taste and colour of pito negatively.

3.3 Traditional Milk Product

3.3.1 "Wara"

Warankasi (commonly abbreviated as wara) is a Nigerian soft, white, unripened cheese which derives its origin from cattle Fulanis from Northern Nigeria, who refer to the liquid from cold milk as "Wara" and the curd texture of the cheese as "Kashi". Wara is popular among the Hausas, Fulanis and the Yorubas of Nigeria. Much of the raw milks produced by the cattle Fulani of Nigeria would have been wasted save for the possibility of wara production. "Wara", is a product of lactic acid fermentation of cow's milk. Being a milk-based product, wara contains appreciable amounts of essential amino acids, minerals and salts of sodium and potassium. It provides a good source of milk for lactose-intolerant people.

Traditional Production of Wara
Fresh cow milk is mixed with Sodom apple leaf extract and heated for about 15-20 minutes. The milk coagulates, the surface scum removed and heating is intensified to boiling (cooking). The loose curd pieces obtained are drained and cut into various sizes for onward transmission to the ultimate consumers. The traditional method of preservation is to hold the fresh product in its whey (the fluid portion of milk drained from the curd) or water, a procedure which keeps wara fresh for 2-3 days in the absence of refrigeration.

Problems Associated with Traditional Production

1. Quality Control
The traditional method has no quality control measures. As a result, the finished product lacked the consistency and finesse of imported cheeses.

2. Hygiene
Traditional processors give little or no regard to hygiene. This is evidenced in the grooming of the processors as well as the processing environment. The implication of this is cross-contamination and microbial infestation which is capable of giving rise to food borne infections and intoxications.

3. Health of Cows
The health of the cows is of paramount importance because it is a function of the quality of milk produced. Little attention is given by the processors to the health of the cows. This

could be due, in part, to the absence of veterinary doctors in nomadic areas as we; as the high cost of veterinary drugs.

4. Shelf Life

Its maximum shelf life is about 2-3 days if stored traditionally. Wara is prone to microbial spoilage because it is highly nutritious.

3.4 Meat Products

3.4.1 "Suya"

"Suya" is a roasted meat product (berbecue) obtained from beef, pork, mutton, chicken and other desirable animals. Although it is peculiar to cattle rearing areas of the country, its acceptability has made it a national product that can be found in all nooks and crannies of the country. It is a common entertainment commodity with drinks (both alcoholic and non-alcoholic) and spices as accompaniments. The popularity of this product underscores the importance of a review of its traditional production.

Traditional Production of Suya

Meat is cut into small flat pieces, rinsed and salted. The salted pieces of meat are then inserted in a pit and sprinkled with pepper and groundnut oil such that its (meats) external surface is covered completely. The resulting product is sundried for about 30-60 minutes after which it is roasted with direct heat from hot coal for about 1-2 hours. The roasted meat (suya) is ready-to-eat when the meat turns brown Suya has no local storage or packaging device, hence, it is regularly reheated to improve its appeal.

Problems of Traditional Processing

1. Intensity of Heat

Hot flames from coal, which is in direct contact with the meat, can lead to burning and destruction of valuable nutrients of the meat.

2. Time Consuming

The process is time consuming as it can take some 4-6 hours to prepare. Considerable time is spent during the manual slicing of meat and preparation of red-hot coals.

3. Ease of Contamination

Suya is commonly displayed uncovered in environments that are anything but clean. This makes the product highly susceptible to microbial attack. In addition, the smoke, which contains good doses of harmful gases like carbon monoxide and hydrogen sulphide, can be source of deleterious chemical changes.

4. Hygiene

The level of hygiene on the part of the processors is generally low. The processing environments and water used in washing fall below expected standards. These conditions predispose the commodity to spoilage and reduces its shelf life.

5. Packaging and Storage

Presently, Suya has no packaging or storage device. The implication of this are:

(i) Only small amounts of meat can be processed at any given time

(ii) Remnants have to be discarded as it cannot stay more than 2 days before deterioration sets in.

(iii) The production process is made highly labour intensive.

6. State of Animal
The processors give no thought to the state of health of animals. In some localities, diseased animals are favourites. In other areas too, the use of carmel meat, which is reputed to have high amounts of mercury, is in vogue. And yet others do not wink an eye at the use of dead animals for suya.

3.4.2 "Tinko"

"Tinko" is a fibrous hard and dried meat product peculiar to cattle rearing areas of the country. It is a delicacy among the Hausas and Yoruba's of the country where it is commonly used in soup preparation and gravies. It is a common form into which raw meat is processed to extend its shelf life locally. Compared to boiled meat, tinko is reputed to have a higher aroma, flavour and protein rating. Many people equally believe that it is more palatable than ordinarily boiled meat.

Traditional Production of Tinko
Live animals, usually camels, donkeys and horses are slaughtered, cut into pieces, washed and parboiled until it is cooked without being soft or tended. Salt and ashes are added and the product is sundried until the meat develops a deep brown colouration. The resulting products in tinko.

Problems of Traditional Processing

1. Nature of the Product
The product has a dirty brown colour and is usually stony, a situation which could predispose consumers to health risks like appendicitis.

2. State of Animals
The use of unhealthy and dead animals is a Common practice. This practice is common in localities where the owner sees the illness or death of his animal as an economic loss. To mitigate his perceived losses, the sick animals or its carcass is processed into tinko. This practice is of public health significance in view of the recent scare of the mad-cow disease.

3. Drying Method
The drying method employed (sundrying) is grossly Inefficient and gives very little consideration to hygiene.

4. Storage Method
The storage method (packing in sacks and baskets) is equally inefficient and inadequate. This gives room for microbial proliferation as well as light and oxygen induced deterioration.

3.5 Fish Products

3.5.1 Smoked Fish

Although the supply of fresh fish is ample only in riverside area of the country, fish processing is not the exclusive prerogative of the fish producing communities. This is due to the availability of frozen fish in non-fish producing communities.

In many developing countries, fish processed by traditional smoking methods are extremely popular. This popularity is due to the chemical changes that occur during the smoking process. In fact it is the chemicals produced during the smoking process that is responsible for the characteristic flavour of smoked fish. Smoked fish has a wide appeal among the general populace. It is a common accompaniment in soups, sauces and other food preparations. The need for proper smoking operation cannot therefore be over emphasized.

Traditional Production of Smoked Fish

Frozen fish is thawed salted and smoked by placement on wire gauze placed atop a smoke source. Where fresh fish is available, it is sometimes folded and kept in place by a broom stick. It is then salted before smoking. In all the cases, the viscera matters are left intact as this is believed to make the final product bulkier. The final product has a fairly shiny gloss with considerable amount of water. Packaging is non-existent and storage is in open baskets.

Problems Traditional Processing

(i) Hygiene

Very little consideration is to given to hygiene. The process is a cottage industry in Nigeria, hence production is usually carried out by women who give very little or no regard to cleanliness. The processing area is also filled with flies while no provision is made for washing prior to the smoking operation. Smoking is done in the open with no provisions made to protect the fish from dusts, pebbles, stones and other extraneous matter.

(ii) Splitting/Evisceration

The guts, gills and kidneys are usually not removed. The high microbial load of these intestinal organs predisposes the locally smoked fish to spoilage.

(iii)Salting

Since traditionally smoked fish are seldom salted, the final gloss and taste is significantly affected.

(iv) Smoking

This is commonly done over open fires from dried wood. However, because it is done in the open, chances of contamination from external sources are quite high.

(v) Storage

There is no particular method of storage. The smoked fish are usually re-smoked at periodic intervals to keep warm. Hence the shelf life of traditionally smoked fish is very low (about 3-5 days)

3.5.2 Dried Fish

Another very popular form to which fresh fish is processed is dried fish. Species commonly used are referred to in Yoruba speaking areas as “agbodo” and “ebolo”. Since a large proportion of fish are locally subjected to the drying operation, a review of the traditional process ensures that appropriate recommendations are made for improvement.

Traditional Production of Dried Fish
Raw fish is salted and exposed to direct sunlight for about 8-14 days until it is sufficiently dry. On the alternative, the salted fish is place on a wire mesh with red-hot charcoal beneath. This is continued till the fish is sufficiently dry. The dried fishes are then stored in baskets and jute bags till it is needed for consumption or sales

Problems of Traditional Processing

1. Sun-drying
Where sun-drying is involved, the product is exposed to hazards of weather and there is virtually no form of protection against insects, pests or rodents attack. Furthermore, sand, stones, faecal matters and other extraneous matters become ingrained in the product. In addition, the drying process is inefficient and grossly inadequate. This can be attributed to the unpredictable nature of weather and intermittent sunshine. This certain level of deterioration may set in before fish finally dries.

2. Handling
The fishes are usually not washed before drying. Where this is done, it is with water of poor drinking quality. In addition, very little regards given to the quality of the raw fish as the primary consideration is purely economic. This in turn imperils the quality of the final product.
It is a very time consuming process especially where sun-drying is involved.

4.0 Conclusion

Food processing techniques are used exclusively in the production of alcoholic and non-alcoholic drinks as sekete, ogogoro, burukutu and pito. Also milk products are turned into cheese by enzymes from leaves. Meat is smoked into suya, while whole fish is smoked into dried fish. Meat is sometimes parboiled and dried into tinko.

5.0 Summary

In this unit we have learnt that:
- Fruits (e.g. tomatoes) are not usually processed but marketed in basket in the fresh state. Vegetables are sold in the fresh or dried form.
- Both alcoholic and non-alcoholic beverages are made from cereals and palm juices.
- Milk is processed into cheese; meat into suya and tinko; fish is popularly smoked.

Self-Assessment Exercise
Describe the traditional production of: (i) Sekete (ii) Ogogoro (iii) Burukutu (iv) Kunnu and (v) Pito.

6.0 Self-Assessment Exercise

Why are the following products acceptable to Nigerians?
1. Suya
2. Tinko
3. Smoked fish

7.0 References/Further Reading

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