# CHEMICAL COMPOSITION AND NUTRITIONAL POTENTIAL OF THE KERNELS OF *NYPA FRUTICANS* AND *COCOS NUCIFERA*

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## *ABSTRACT*

The nutritive value of the kernels of *Nypa fruticans* (nypa palm) and *Cocos nucifera* (coconut tree) were chemically evaluated and the kernels flour was used as component in confectionery (biscuit) preparation. The proximate composition of both the kernels and their biscuits were determined; Vitamins A and C, toxic substances (anti-nutrients) and the mineral elements levels were also evaluated. It was found that nypa kernel contained very little amount of crude fat 0.04 ± 0.06% compared with 63.16 ± 0.07%) for coconut while carbohydrate, the crude protein and crude fibre contents were higher in the nypa kernel than in coconut. Vitamin C content in nypa kernel was greater than coconut while vitamin A content was higher in the coconut than in the nypa kernel. The levels of anti-nutrients and mineral elements were within the acceptable levels in both kernels. The proximate composition of the biscuits made from nypa kernel- wheat composite flour mixture and coconut – wheat composite flour mixture indicated that the composite biscuit compared well in nutritive values with wheat biscuit containing only commercial wheat flour while the general acceptability evaluated from organoleptic tests ranked nypa biscuits as the most acceptable confectionery preparation seconded by wheat biscuit.

## INTRODUCTION

*Nypa fruticans* and *Cocos nucifera* are two palm trees belonging to the Arecaceae family of the flowering plants. For centuries, many palm species have been exploited to produce fresh juice, edible kernels/fruits and oil; building materials, water troughs and many other chemically modified industrial products which are of national economic importance. *Cocos nucifera* (Coconut palm) is known for its refreshing juice, succulent and nutritious kernel well developed seed fibres for mat making and floor carpet; its leaf petioles are used for arrows and brooms; vegetable oil extracted from the kernels is used in the food and soap industries while the kernel is used in confectionery preparations. The kernel of *Cocos nucifera* is accepted all over the world as food item. However, *Nypa fruticans* (nypa palm) is regarded as an exotic wild palm in Nigeria and its kernels are not eaten as food.

Nypa palm was introduced into the country between 1905 and 1912 along the coasts of Calabar and Oron to check erosion menace in the coastal towns

of Calabar and Oron in the South Eastern State of Nigeria[1]. However, the plant has become invasive and has grown tremendously westward into Rivers, Bayelsa, Delta and Ondo States. The plant is replacing the traditional mangrove species at the coastal zone of Nigeria, and at the same time blocking the creeks and river estuaries with their floating leaves and seeds. Although in Indonesia and Malasia where nypa palm is native, nypa palm has been exploited for useful products, in Nigeria, the leaves are used in making mats for roofing thatch houses, the leaf petioles are used for brooms and arrows while the hard kernels are used as trinkets; there are no records on their application in any food preparation.

In this work, the chemical composition of both the nypa kernel and the coconut kernel were determined, their flours mixed with wheat flour were used in making biscuits (confectionery) and the proximate composition and acceptability (organoleptic) tests were carried out on the biscuits. Their results were compared and their nutritional potentials assessed.

## MATERIALS AND METHODS

The matured nypa palm and the coconut fruits were collected at a swamp near Oron Museum Beach in Akwa Ibom State, the fruits were dehusked with a clean machete and the kernels (endosperm) of the nypa palm fruit obtained; in the case of coconut fruit the nut was cracked before removing the kernel while the juice being discarded.

### Proximate Analysis

The conventional methods approved by Association of Official Analytical Chemists[2] were used for proximate analysis. The parameters determined were the moisture content by gravimetric method, crude fat by extraction with petroleum ether (Bp. 40 – 60$^0$C) using Soxhlet extractor; crude fibre by consequential treatment with 1.25% (v/v) $H_2SO_4$ and 1.25 (w/v) NaOH solutions and thorough washing with hot water and 90% ethanol before drying at 100$^0$C and igniting at 500$^0$C in a furnace. The difference in weight of the dry residue and the ash constituted the crude fibre.

The crude protein was determined as ammonia nitrogen using Kjeldahl apparatus, while the carbohydrate content, excluding the crude fibres was obtained as the difference after subtracting the total organic nitrogen, crude fat and crude fibre from the dry matter. The caloric value in kcal/100g was obtained by multiplying the value of the crude protein, crude fat and carbohydrate by 4, 9 and 4 respectively and taking the sum.

The anti-nutrients determined were hydrocyanic acid (HCN), phytate, oxalate (soluble and insoluble) and tannins using standard methods[3].

The mineral elements were determined using AAS (Atomic Absorption Spectrophotometer) after digestion in the appropriate reagents[3]. They were Mg, Ca, Fe, Mn and Cu; the actual values were read from the calibration curves for each metal. K and Na were determined using flame photometer,

they were calculated in amount per 100g sample. The vitamins A and C were determined by standard methods[3].

**Preparation of Biscuits**

Preliminary experiment carried out showed that a composite flour mixture containing 27.93% nypa kernel or coconut flour and 46.56% wheat flour together with additives constituting 25.51% formed nice crispy biscuits, hence these composite flour mixtures were used in preparing nypa biscuits and coconut biscuits while wheat biscuits contained only wheat flour as recipe (Table I).

**Table 1: Biscuit Recipe**

| Ingredients | Nypa-wheat Biscuits | Coconut Biscuits | Wheat Biscuits |
|---|---|---|---|
| Wheat flour | 150g(46.56%) | 150g(46.56%) | 240g(74.49%) |
| Nypa kernel flour | 90g(27.93%) | - | - |
| Coconut flour | - | 90g(27.93%) | - |
| Sugar | 40g(12.42%) | 40g(12.43%) | 40g(12.43%) |
| Fat | 20g(6.21%) | 20g(6.21%) | 20g(6.21%) |
| Baking powder | 10g(3.10%) | 10g(3.10%) | 10g(3.10%) |
| Salt (sodium chloride) | 0.2g(0.06%) | 0.2g(0.06%) | 0.2g(0.06%) |
| Egg | 12.0g(3.72%) | 12.-g(3.72%) | 12.0g(3.72%) |
| **Total** | **322.2g** | **322.2g(100%)** | **322.2g(100%)** |

The method used in the preparation of biscuits involved creaming of the fat and sugar mixture, mixing and sieving of the flour mixture, addition of the baking powder and salt (NaCl) to the flour mixture[4]; then preparation of the batter by adding egg and cream mixture (fat and sugar) to the flour mixture; tossing of the batter over dried nypa flour or coconut flour and wheat flours spread on a board. The batter was rolled out into a suitable thickness. The cut batter pieces were then baked in an oven set at a temperature of 177$^0$C for 10 – 15 minutes after which they were cooled to room temperature (27$^0$C) and examined physically. Organoleptic tests and proximate analysis of the biscuits were carried out and their acceptability and nutritive value levels assessed.

## RESULTS AND DISCUSSION

**Table 2: Proximate composition and caloric values of the kernels of nypa palm and coconut**

| COMPONENT | (Percentage on dry weight) mean ± standard error | |
|---|---|---|
| | Nypa Palm kernel | Coconut kernel |
| Moisture content (fresh) | 34.80 ± 0.15 | 39.33 ± 0.06 |
| Ash | 3.46 ± 0.04 | 2.55 ± 0.05 |
| Crude fat | 0.40 ± 0.06 | 63.16 ± 0.07 |
| Crude protein | 5.60 ± 0.03 | 4.20 ± 0.09 |
| Carbohydrate | 87.56 ± 0.09 | 29.19 ± 0.18 |
| Crude fibre | 2.45 ± 0.05 | 0.9 ± 0.06 |
| Caloric value kcal/100g | 394.69 ± 0.29 | 695.40 ± 0.93 |

The moisture content of nypa palm kernel was 34.80 ± 0.15% and that of coconut was 39.33 ± 0.06, (Table 2). These values are higher than those earlier reported, 2.5% obtained for coconut kernels[5] which were based on air dried, fully matured samples as against the fresh samples used in this study. The values were still also higher than those obtained for Date palm (22.5%)[6] and Sango palm (27.0%). Experience shows that moisture content of fresh kernels is related to the maturity of the kernels. The high moisture content indicates that, to maintain the kernels in good conditions, these kernels must be stored under specific conditions of temperature and relative humidity and the dried, matured samples can be stored for a longer period than the fresh ones. The crude protein contents were 5.60 ± 0.03 and 4.20 ± 0.09% for nypa kernel and coconut kernel respectively. The crude fat (lipid) content was surprisingly low for the nypa palm kernel (0.4 ± 0.6%) as against 63.16 ± 0.07% for the coconut kernel which is regarded as an oil seed. Coconut oil has generally been used as edible vegetable oil and it is also important industrial oil in soap manufacturing. However, the lipid content of nypa palm kernels is in line with those of other palm kernels/seeds e.g. Areca (ripe nut) (0.12 – 0.24%), Buri palm (0.5%)[7], palm heart (0.08 – 0.33%)[8], African Doum palm (0.8%)[9] and Date palm (0.5%)[6]. Thus the nypa palm kernel is a poor source of crude fat. On the other hand the carbohydrate content (excluding crude fibre) of nypa palm kernels (87.50 ± 0.09%) is greater than that of coconut (29.19 ± 0.18%) and compares well with those of other tropical palms namely; Palmyra (sugar palm) (98.89%); Buri palm (93.7%); Limuran palm (88.6%); Doum palm (84.1%) and Salak palm (95%)[7,9,10]. The crude fibre content in nypa palm kernel (2.45 ± 0.05%) is also higher than that of coconut (0.90 ± 0.06%). It was this high amount of carbohydrate content that suggests the application of nypa palm kernel flour in confectionery (biscuit) preparation. Caloric value of nypa palm is 394.69 ± 0.29 kcal/100g while that of coconut is 695.40 ± 0.03 kcal/100g. The

higher value of the latter compares well with that of an oil kernel of African oil palm (746kcal/100g) [5,7,10] while the value for nypa palm kernel is similar to that of Salak palm (345kcal/100g), a non-oil kernel with similar proximate composition, however the two kernels can supply useful quantity of energy required for daily activities.

The ash content (3.46 ± 0.04, 2.55 ± 0.05%) of nypa palm and coconut kernels respectively, is similar to those of kernels e.g. Salak palm (3.2%); Areca nut (1.2 – 2.5%)[5,11,10].

**Table 3: Mineral content of nypa kernel and coconut kernel**

| Mineral Elements | Composition (mg/100g dry weight) mean ± standard error | |
|---|---|---|
| | Nypa Palm kernel | Coconut kernel |
| Magnesium | 90.60 ± 8.5 | 9.06 ± 0.08 |
| Potassium | 47.93 ± 4.0 | 8.72 ± 0.85 |
| Calcium | 19.30 ± 0.40 | 22.85 ± 0.11 |
| Sodium | 128 ± 0.24 | 78.40 ± 0.21 |
| Manganese | 10.63 ± 0.14 | 2.77 ± 0.00 |
| Iron | 2.13 ± 0.05 | 2.23 ± 0.02 |
| Copper | 0.70 ± 0.02 | 1.12 ± 0.03 |

The higher value of ash is reflected in the mineral element content shown in the Table 3, in which the mineral elements in nypa palm kernel Mg, K, Na, Mn and Cu are more in quantity than those in coconut. All the elements are within the tolerable amount for man and animals hence do not pose danger to health if the nypa palm kernels are used as component of food since the coconut is a popular food item. The vitamin A (retinol) and vitamin C (ascorbic acid) content were (2.57 ± 0.23; 20.36 ± 0.9mg/100g, (dry weight)) for the nypa palm kernel and (10.81 ± 0.08; 16.84 ± 0.50mg/100g (dry weight)) for the coconut kernel (Table 4).

**Table 4: Vitamin content in the kernels of nypa palm and coconut palm**

| VITAMINS | (mg/100g dry weight) mean ± standard error | |
|---|---|---|
| | Nypa Palm kernel | Coconut kernel |
| Vitamin A | 2.57 ± 0.23 | 10.81 ± 0.80 |
| Vitamin C | 20.36 ± 0.07 | 16.84 ± 0.50 |

From above values, vitamin C content in nypa palm kernel is greater than that in coconut while vitamin A content is higher in coconut than in nypa palm kernel. These vitamin A and C are useful in the normal functioning of the body because vitamin A is needed for normal vision and growth of new cells which line the respiratory, digestive and reproductive tracks in the body while vitamin C aids in the prevention of scurvy, formation of collagen

and dentin (hard cover of the tooth); these quantities of vitamin A and C are in line with those of similar palms, hence these kernels can serve as components for food preparation so as to add more vitamin A and C to the foodstuff.

**Table 5: Levels of toxic substances (anti-nutrients) in nypa palm kernel and coconut kernel**

| Toxic Substances | Composition (mg/100g dry weight) mean ± standard error | |
|---|---|---|
| | Nypa Palm kernel | Coconut kernel |
| Hydrogen cyanide | 15.6 ± 0.00 | 10.80 ± 0.17 |
| Tannin | 2.26 ± 0.39 | Not Detected |
| Phytic acid | 1.13 ± 0.09 | 1.01 ± 0.01 |
| Total oxalate | 139.04 ± 0.04 | 93.28 ± 0.02 |
| Soluble oxalate | 83.60 ± 0.93 | 74.80 ± 0.05 |
| Insoluble oxalate in total oxalate | 55.4 ± 0.92 | 18.48 ± 0.03 |

The anti-nutrient content in these kernels are shown in Table 5. They are the hydrogen cyanide (HCN), phytate in the form of phytic acid, total oxalate and soluble oxalate. The values, as shown in Table 5 are higher for nypa palm kernel than those for the coconut kernel. The quantities of these toxic substances in the kernels are lower than the lethal dose of 2.5g/100g for man[12,13], however, their presence in the kernels prevent the kernels from being attacked by insects and other pests.

**Quality of Confectionery Product**

**Table 6: Proximate Composition and the caloric values of the Biscuits samples**

| Parameters | Percentage dry weight | | |
|---|---|---|---|
| | Wheat Biscuit | Nypa Biscuit | Coconut Biscuit |
| Moisture content (air dry) | 2.51 ± 0.01 | 3.70 ± 0.10 | 5.20 ± 0.03 |
| Ash | 1.20 ± 0.03 | 1.65 ± 0.01 | 1.35 ± 0.03 |
| Protein | 3.92 ± 0.01 | 2.38 ± 0.50 | 6.22 ± 0.05 |
| Crude fat | 14.50 ± 0.03 | 7.45 ± 0.01 | 19.50 ± 0.01 |
| Crude fibre | 0.80 ± 0.00 | 1.13 ± 0.03 | 0.90 ± 0.01 |
| Carbohydrate | 80.24 ± 0.60 | 86.78 ± 1.01 | 70.71 ± 0.60 |
| Caloric value (kcal/100g) | 464.52 ± 0.06 | 427.67 ± 1.20 | 485.83 ± 2.27 |

Table 6 shows the proximate composition of biscuits made from wheat 74.49% flour, 27.93% nypa kernel and 46.56% wheat composite flour mixture and from 27.93% coconut and 46.56% wheat composite flour mixture. The additives in biscuit receipt constitute 25.51% while the wheat flour biscuits served as the control.

The moisture content of the coconut wheat composite flour biscuit (coconut biscuit) had the highest moisture content of 5.20 ± 0.03% based on air dried sample while the nypa biscuits (nypa kernel – wheat composite flour biscuits) was 3.70 ± 0.10% while wheat flour biscuit had the least, 2.51 ± 0.10%. There exists a significant difference between the moisture content of wheat biscuits and coconut biscuits ($t = 89.67$, $P<0.05$) with percentage difference of 2.69 as well as between wheat biscuits and nypa biscuits ($t = 11.90$, $P<0.05$) with percentage difference of 1.19 (Table 9); thus the trend of moisture content is coconut biscuits > nypa biscuits > wheat biscuits which is the reverse order of the shelf-life of food substances, this trend suggests that nypa biscuits may have longer shelf-life than coconut biscuits. It has been reported that the moisture content of food could influence the shelf life of food; for increase in moisture content leads to increase in enzymatic and microbial activities which deteriorate food substances[14].

**Table 7: Percentage differences and t-test value between wheat, nypa palm and coconut biscuits.**

| Parameter (Dry matter) | Wheat and Nypa Biscuits | | Wheat and Coconut Biscuits | |
|---|---|---|---|---|
| | % Difference | $t_{cal}$-$t_{crit}$ | % Difference | $t_{cal}$-$t_{crit}$ |
| Moisture content | 1.19 | 11.90 | 2.69 | 89.67 |
| Ash | 0.45 | 14.06 | 0.15 | 3.57 |
| Protein | 1.54 | 30.80 | 2.30 | 45.10 |
| Crude fat | 7.05 | 220.31 | 5.00 | 156.30 |
| Crude fibre | 0.33 | 1.10 | 0.10 | 1.00 |
| Carbohydrate | 6.54 | 5.57 | 9.53 | 11.21 |
| Caloric value (Kcal/g) | 36.85 | 15.81 | 21.31 | 9.39 |
| n = 3 | $t_{crit}$ = 4.13 | P < 0.05 | | |

As shown in Table 7 there is no significant difference between the ash contents of wheat biscuits and coconut biscuits ($t = 3.57$, $P<0.05$, $\% \Delta = 0.15$) but there was a significant difference between the ash content of the wheat biscuits and nypa biscuits ($t = 14.06$, $P < 0.05$, $\% \Delta = 0.45$). This implies that nypa biscuits have a tendency to retain mineral elements at temperatures as high as 177$^0$C (the oven temperature) than coconut and wheat biscuits, however since initially the mineral elements present in nypa kernel are within tolerable limit in man, the amount in the biscuit should not pose any danger to the health of anyone who consumes nypa biscuits. The protein contents of the biscuit samples are not high however, Table 7 shows that there was a significant difference between the protein contents of wheat biscuits and nypa biscuits ($t = 30.80$, $P<0.05$, $\%\Delta = 1.54$) and also between the wheat biscuits and the coconut biscuits ($t = 45.10$, $P<0.05$, $\%\Delta = 2.30$), but since biscuits are not generally eaten as a source of protein, low protein content may not affect the acceptability of nypa biscuits as food item.

There exists a significant difference between the crude fat contents of wheat biscuits and nypa biscuits ($t = 220.31$, $P<0.05$, $\%\Delta = 7.05$) (Table 7) while the nypa biscuits has the lowest crude fat content, therefore nypa biscuits should be suitable for those who require low fat diet. Tables 6 and 7 also show that there was no significant difference between the crude fibre content in the three biscuit samples. On the other hand nypa biscuits had the highest carbohydrate content 86.78 ± 1.01% followed by that of the wheat biscuits while the coconut biscuits had the lowest (Table 6) showing significant difference in their carbohydrate contents, thus nypa biscuit should provide adequate carbohydrate food necessary for the body growth. Similarly the nypa biscuits had the highest caloric value 485.83 ± 2.27 kcal/100g as against 464.52 ± 0.14 kcal/100g and 427.67 ± 1.2kcal/100g for the wheat and coconut biscuits respectively, showing that nypa biscuits and coconut biscuits can provide good amount of energy for normal body activities when eaten as food. The acceptability of nypa kernel biscuits was evaluated by organoleptic test administered to a panel of 10 whose rating are shown in Table 8.

**Table 8: Organoleptic tests on wheat biscuits, nypa biscuits and coconut biscuits**

| Test | Wheat Biscuits | Nypa Biscuits | Coconut Biscuits |
|---|---|---|---|
| Flavour | 4 | 4 | 5 |
| Texture | 4 | 5 | 3 |
| Appearance | 5 | 5 | 3 |
| Overall Acceptability | 4 | 5 | 3 |

1 = Dislike mildly
2 = Dislike
3 = Neither like nor dislike
4 = like mildly
5 = Like definitely

Coconut biscuits was preferred highest by 96% ($\mathbf{X} = 4.80$) of the panel based on flavour while wheat biscuits was preferred by 84% ($\mathbf{X} = 4.20$) and nypa biscuits by 78% ($X = 3.90$). The natural flavour and sweetener present in coconut positively influenced the taste of the coconut biscuits, hence the higher the amount of coconut flour substituted for wheat flour the richer the taste/flavour. In terms of texture nypa biscuits were crispier than coconut and wheat biscuits and 98% ($X = 4.90$) of the panel members preferred nypa biscuits to the others, 84% ($X = 4.20$) preferred wheat biscuits and 56% ($X = 2.80$) preferred coconut biscuits. The appearance of biscuits was attractive, however the order of preference was nypa biscuits (80%, $X = 3.50$) > wheat biscuits (68%, $X = 3.40$) > coconut biscuits (36%, $X = 1.80$). The overall acceptability was based on above tests and was determined by calculating the mean percentage rating of the factors: flavours, texture and appearance. The results obtained was in the order (93.33%, $X = 4.66$) for nypa biscuits >

(86.67%, X = 4.33) for wheat biscuits > (73.33%, X = 3.65) for coconut biscuits giving nypa biscuits i.e. nypa – wheat (37.5: 62.5%) composite flour mixture biscuits the most acceptable preparation.

## CONCLUSION

The results obtained from the chemical composition of the samples showed that nypa palm kernel contained higher levels of ash, fibre, carbohydrate, vitamin C, manganese, potassium, sodium and magnesium than those in coconut while the moisture content, crude fat, vitamin A, calcium, iron, copper levels and caloric value are higher in coconut than in nypa palm kernel. The anti-nutrient content of the sample kernels showed that their levels are higher in nypa kernel than in coconut, but their concentrations are below the levels that are lethal to man.

The proximate analysis of the biscuits made from nypa-wheat composite flour mixture and coconut-wheat composite flour mixture indicated that these biscuits contained nutrients that compared well with the traditional wheat biscuits. The organoleptic tests evaluation places nypa biscuits to be the most acceptable preparation. Therefore based on these results the nypa palm kernels, which are not presently used as food ingredient are suitable for confectionery preparation just as coconut kernel is presently utilized; in addition, the low fat content in nypa kernel implies that nypa biscuits are most suitable for the people who require low fat food to maintain good health.

## REFERENCES

1. Ojebo, O. D. (2002): Nypa Palm control Programme, paper presented: Proceedings of the Launching of Delta State Chapter of Nypa Palm control programme by the Hon. Minister of State, Ministry of Environment, Chief Dr. T. Ime Okopido. http.//www.delta/state.gov.ng/environment html.
2. A. O. A. C. (Association of Official Analytical Chemists) (1985). Official Methods of Analysis 14th Edition, Benjamin Franklin. Station, Washington D. C. ed. William Horwitz.
3. Vogel A. I. (1962): A textbook of Quantitative Inorganic Analysis 3rd edition, London Longman Group Ltd. Pp. 882 – 885.
4. Adebisi, V. (1985): Bread, Cakes and Pastries in: A cookery Book for the Tropics. George Allen and Unwin, London.
5. Okwu, D. E. (2000): Improving the Nutritive value of Cassava Tapioca Meal as Animal Feed with local spices. Department of Chemical Science, Federal University of Agriculture, Umudike Book Proceedings 25th Annual Nigeria Society for Animal Production (NSAP) Conference. 19 – 23, March 2000.
6. Watt and Merill (1963): Proximate Composition and Uses of Date Palm In: Non-Wood Forest Product. Their Characteristics and composition:

Integrated Production System Published 1998, FAO Document Repository.

7. Atchley J. (1984): Proximate composition and uses of Salak Palm, Moriche Palm, African Oil Palm, Buri Palm and Limuran Palm in: "Non Wood Forest Products. Their characteristics and composition. Integrated Production System, Published 1998. FAO Document Repository.
8. Quast and Bernhardt (1978): Proximate composition and Uses of palm heart. In: Non Wood Forest Product Their Characteristics and composition. Integrated Production System, Published 1998. FAO. Document Repository.
9. Hoebeke (1989): Proximate composition and uses of African Doum Palm in: Non Wood Forest Products; Their Characteristics and Composition. Integrated Production System, published 1998. FAO Document Repository.
10. Davis and Johnson (1987): Proximate composition and Uses of *Borassus flabellifer*, In: Non Wood Forest Products Their characteristics and composition: Integrated Production System, Published 1998. FAO Document Repository.
11. Temple V. J. Osagie, A. U. Eka, O. U. (1998): Lesser Known Plant Foods In. Nutritional Quality of Plants Food. Post Harvest Research Unit, Department of Biochemistry, University of Benin Pp. 245 – 274.
12. Oke, O. L. (1969): Role of Hydrocyanic Acid in Nutrition. World Review of Nutrition and Dietetics, II, 170 – 198.
13. Edem, D. O., Eka, O. U. and Ifon, E. T. (1985): Chemical Evaluation of the Nutritive values of the Fruit of African star Apple *(Chrysophyllum albidium)* Food Chemicals *14:* 303 – 311pp.
14. Okaka, J. C. and Okaka, A. N. C. (2001): Foods: Composition, Spoilage, Shelf-life Extension. Oc Janco Academic Publishers, Enugu, Nigeria.