THE INTERNATIONAL JOURNAL OF SCIENCE & TECHNOLEDGE

Comparative Analysis of the Physicochemical and Sensory Properties of Monkey Kola (Kola Lepidota) Juice Blended With Pineapple (Ananas Cosmosus) Juice

Njoku Ha
Lecturer, Department of Food Science and Technology, Ebonyi State University, Nigeria
Onu Tc
Lecturer, Department of Home Economics, Enugu State College of Education (Technical), Nigeria
Egbuna Hi
Lecturer, Department of Nutrition and Dietetics, Anambra State Polytechnic, Nigeria
David Ei
Lecturer, Department of Home Economics, Ebonyi State University, Nigeria
Ogoh Nv
Lecturer, Department of Biochemistry, Ebonyi State University, Nigeria
Mgbebu Po
Lecturer, Department of Food Science and Technology, Ebonyi State University, Nigeria

Abstract:
This study was aimed at evaluating the physical, chemical and sensory properties of juice developed from monkey kola juice and pineapple juice and its blend. It tends to extract juice from pineapple and monkey kola and blend the two juices; to determine the mineral and vitamins of the juice produced; to evaluate the physical properties; to determine the sensory properties of the juice. Locally prepared pineapple juice was used as the control. Complete randomized design was the experimental design used for the study, while LSD was used to determine significant different among sample at ($p<0.05$). Most of the physical properties were not significantly different from each other. The pH value ranges from 3.81 – 4.33%, Brix 8.51 – 15.51%, % acidity 0.79 – 3.59% and specific gravity 0.89 – 3.19. Sample B which is the monkey kola juice had the highest value for calcium, and phosphorus 35.87 and 8.87mg/100g respectively. Sample B also had the highest value for vitamin C compared to the control but low in vitamin E when compared to the control (sample C), sample A which is the blend of monkey kola juice and pineapple juice has the highest value for all the sensory attribute which include taste, mouth feel, appearance, flavor and general acceptability. The low in vitamin and low sugar content of juice produced from monkey kola makes juice suitable to be incorporated into the diet of people with the history of heart attack and diabetes.

Keywords: *Product development, monkey kola, pineapple, fruit, Juice, nutrients*

1. Introduction

Fruit is a structural part of plant that contains seeds, normally fresh, sweet and edible in the raw state, which includes orange, pineapple, grapes, straw berries and water melon etc. (Mauseth, 2003). They are ripe ovaries or carpels that contain seeds (MeGee, 2004). Fruits are also plant parts which have aromatic fragrant characteristics and are usually sweet or sweetened before eating. All fruits contain high percentage of water averaging 85%. Most fruits are eaten as desert and they can be processed into liquid products which include fruit juices, wine and other preserves like marmalade, jams, jellies etc. There are also different kinds of tropical fruits available for the production of fruit juice. They include pineapple, grape, lime, lemon, orange, paw-paw, guava, tangerine etc. These tropical fruits can also be mixed to produce mixed fruit juice.

Juice is a liquid that is naturally contained in fruits and vegetable. It can also be referred to as liquids that are flavoured with other biological food sources such as meat and sea foods. It is commonly consumed as a beverage or used as an ingredient or flavouring in foods or other beverages. Juice is prepared by mechanically squeezing of macerating (sometimes referred to as cold pressed) fruit or vegetable flesh without the application of heat or solvents. Example, pineapple juice is the liquid extract of the fruit of pineapple; other examples include orange juice from orange fruit, carrot juice from carrot tuber, apple juice from apple tree etc.

Pineapple (Ananas comosus) is a tropical plant with edible multiple fruit consisting of coalesced berries, also called pineapple (dictionary reference.com, 2005), and the most economically significant plant in the Brometuceae family (Coppens d' Eeckenburge et al., 2003). Pineapple can be consumed fresh, cooked, juiced or preserved; they are found in a wide array of cuisines.

Monkey kola is an underutilized fruit found in southern-eastern Nigeria. It belongs to the family Sterculiaceae; and genus cola. It is made up of three varieties; red varieties (cola latertia), white variety (cola parchycarpa) and yellow variety (cola lepidota) (Singh et al, 2010). The red specie is not very common but the white and yellow species are commonly found in southern Nigeria between the months of June to November (Ogbu et al, 2007). The pod of the yellow variety is roundish**,** while the white variety has mate cylindrical shape. Monkey kola is identified by various local names in south-easier-. Nigeria ('achicha' or 'ohiricha' in Igbo and 'Ndiyah' in Efik). Monkey kola has nutritional and medicinal value (Singh, 2010).

The outcome of this study intends to promote food security and eradicate micronutrient deficiency (hidden hunger). The objectives of the study include - to extract juice from pineapple and monkey kola and blend the two juices; to determine the mineral and vitamins of the juice produced; to evaluate the physical properties; to determine the sensory properties of the juice.

2. Materials and Methods

2.1. Source of Raw Material

The pineapple was purchased from Meat Market, Abakaliki, while the monkey kola was purchased from Orie-egbe Market, Abakaliki, Ebonyi State.

2.2. Preparation of Juice

2.2.1. Preparation of Pineapple Juice

Pineapple juice preparation was done through the flowchart describe by Akinosun (2010).

- Pineapple
- Sorting
- Washing
- Peeling
- Cutting
- Extraction (using electric blender)
- Filtering (using muslin cloth)
- Pineapple juice

2.2.2. Preparation of Monkey Kola Juice

Monkey kola juice preparation was done by the method described by the wonder of carrot juice (2011).

2.2.2.1. Flowchart for the Monkey Cola Juice preparation

- Sorting
- Removal of the back
- Separation of pulp from seeds
- Washing
- Cutting
- Blending with little water
- Adding water to the blended pulp
- Sieving with muslin cloth
- Monkey cola juice

2.2.3. Determination of Physical Properties

2.2.3.1. pH

The pH of the juice was determined using a digital pH meter (pHs-2F, Harris, England) according to AOAC method. Twenty (20ml) of the juice was transferred into a beaker and the pH was determined after the meter was calibrated using standard buffer solution. Sufficient time was allowed for equilibration before readings were taken.

2.2.3.2. Titratable Acidity (TTA)

Ten (10ml) of the juice was pipette into a cooled flask and 25ml of distilled water added as described by AOAC. Two hundred meters (200ml) of 0.1m NaOH was poured into a burette and was titrated against the sample in the flask using three drops of phenolphthalein as indicator. It was titrated until a pink colouration was observed and then corresponding burette reading was taken.

2.2.3.3. Total Sugar Content (BRIX)

The hand-held sugar refract meter was used. The prism of the refract meter was cleaned and a drop of the juice was placed on prism and closed. The total sugar content (Brix) was read off the scale of the refract meter when held close to the eye according to the method of AOAC.

2.2.3.4. Specific Gravity

The bottle method was used, the bottle was weighed, filled with the juice and weighed again. The difference in weights was divided by the weight of an equal volume of water and the specific gravity of the juice was got according to AOAC.

2.2.4. Mineral Elements Determination

Mineral element was determined using wet-acid digestion methods for multiple nutrients determination as describe by the method of AOAC (2006). About 0.2g of the S processed sample was weighed into a 150ml pyrex conical flask. Five (5.0) ml to the extracting mixture (H_2So4-soklium salicylic acid) were added to the sample. The mixtures were allowed to stand for 16hours. The mixture was placed on a hot plate set at 30°c and allowed to heat for about 2hours. Five (5.0) ml of concentrated perchloric acid was added to the sample and heated until the sample was digested to a clear solution. Twenty (20) ml of distilled water was added and heated to mix thoroughly for about a minute. The digest was - allowed to cool and transfer into a 50ml volumetric flask and made up to the mark with distilled water. The digest was for the determination of calcium (Ca) and magnesium (Mg) by the ethylamine ditetracetic acid (EDTA) versanate complexiometric titration method and phosphorus (P) by the vanadomelybdate method using the spectrometer.

2.2.5. Vitamin A and E Determination

10g of each sample was measured into volumetric flask and 50ml of acetone and 50ml of boiling petroleum ether was added, shaken at interval and filtered. The residue was discarded and the volume of the filtrate measured. Twenty-five gramme (25g) of Nacl was weighed and dissolved in 50ml of water and added to the solution which separated into layers, the supernatant was collected using a separating funnel and equal volume of 4% k_2CO_3 equivalent to volume of the filtrate was added and continues washing with distilled water until a clear solution was obtained, the extract was taken and at the absorbance was read with spectrophotometer at the wavelength of 432nm.

2.2.5.1. Vitamin C Determination

Ascorbic acid was determined using titration method as describe by AOAC (2006). 5grams of the sample, 20ml of distilled water, 2.5ml of H_2So_4 was weighted into a conical flask. 5ml of 1% starch was weighed and poured into the conical flask and titrated with Iodine solution.

2.3. Sensory Evaluation

Sensory evaluation of the juice produce was carried out with a set of 20 panelists. Ordinary pineapple juice was produced and used as the control. The panelist consists of both male and female students of Food Science and Technology Department of Ebonyi State University Abakaliki. The panelist evaluated for flavour, taste, appearance, mouthfeel and overall acceptability of the two different juices.

2.4. Statistical Analysis

The design for the experiment was complete randomized design. LSD was used to determine significant different among sample at ($p<0.05$) (Okporie (2006).

3. Results and Discussion

3.1. Physical Properties

Physical	Samples			
properties	A	B	C	LSD
pH	3.83±0.01[a]	3.91±0.01[a]	4.33±0.01[a]	3.76
Brix	12.26±0.01[b]	8.51±0.01[c]	15.51±0.01[a]	0.06
%Acidity	0.79±0.0[c]	1.99±0.005[b]	3.59±0.003[a]	0.24
Specific	0.89±0.05[c]	2.38±0.02[b]	3.19±0.03[a]	0.24

Table 1: Physical Properties of Juice Developed from Monkey Kola, Pineapple and Its Blend

Means with different superscripts along the same row are statistically different from each other ($p \leq 0.05$). A – Blend of pineapple and monkey kola juice, B – monkey kola juice, C – pineapple juice.

3.1.1. pH

The physical properties of the sample evaluated showed that the pH values of the juice ranges 3.83 – 4.33 for samples A and C respectively as presented in Table 1. This falls within the range of 3-5 for fruit and vegetable juice as reported by Haris et *al,* there were no significant difference ($p<0.05$) in the pH values of all the samples A, B and C, the reference sample (3.83, 3.91 and 4.33) respectively several researchers have reported fruit juices with different pH values. Adubofuor *et al,* reported a range of 4.3 = 82–4.99% for cocktail juices, Ndife *et al,* observed a range of 3.23–4.08% for different brands of range juices, as well as Emelik *et al,* reported 4.1% for fresh cashew apple juice.

3.1.2. Titratable Acidity

The titrate acidity value i.e. (% acidity) of the sample has the sample C as the reference with the highest value 3.59% and sample of the blend of pineapple and monkey kola juice as the lowest 0.79%. This is in line with the pH value of pineapple that ranges from 3.48 – 6.23% as reported by Richard As are. A significant difference of ($p<0.05$) was observed in all the sample food acidity dictated the dominant microflora in foods and to a large extent will determined the shelf stability of the juice (Ezeama, 2007). The more acidic the juice, the less susceptible bacterial action but the more susceptible to the action of yeasts and moulds. Jay (2000).

3.1.3. Total Sugar Contents (Brix)

The total sugar content (Brix) ranges from 8.51 – 15.5% (sample B and C) respectively and showed marginal significant difference (0.06) in all the samples. This is in close relationship with the range of 9.15–14.25% reported by Ndife *et al,* for different brands of orange juice. Pineapple juice has the highest value for specific gravity followed by monkey kola juice and the blend of monkey kola and pineapple juice, which ranges from 3.19–0.89% for sample C the reference sample and A, respectively, and a marginal significant difference was observed in all the samples at ($p = 0.06$).

3.1.4. Specific Gravity

The specific gravity is higher in sample B and C (monkey kola and pineapple juice) than in sample A (the blend 50/50). The specific gravity of B (monkey kola juice) is relatively higher than the reported by Richard Asare. According to Smith (1998), specific gravity may be useful as a fruit grading index for differentially entry quality as well as maturity.

3.2. Mineral Contents

Nutrient	**Samples**			
	A	B	C	LSD
Calcium	11.44 ± 0.18^{c}	35.87 ± 0.2^{a}	22.30 ± 0.22^{b}	1.18
Magnesium	10.71 ± 3.79^{a}	9.30 ± 3.29^{c}	9.38 ± 3.32^{b}	22.61
Phosphorus	3.7 ± 0.07^{b}	8.87 ± 0.02^{a}	9.07 ± 0.08^{a}	0.35

Table 2: Mineral Composition of Juice Developed from Monkey Kola Juice and It's Blend with Pineapple Juice

Means with different superscripts along the same row are statistically different from each other ($p<0.05$) A = Blend of monkey kola juice and pineapple (50/50), B = monkey kola juice, C pineapple juice the reference.

The mineral composition of the juice developed from monkey kola, pineapple and its blend is shown on table 2. The dominant minerals in the juice is calcium while phosphorus is relatively low.

3.2.1. Calcium

The calcium content of A (monkey kola) juice (35.87/100g) was higher than that of C (pineapple juice which is the reference) (22.3mg/100g) and the blend) (11.44mgg/org). The high calcium found in A (monkey kola juice) may be attributed to varietal differences. When compared to other fruit juices, the calcium content of monkey kola juice is significantly higher than the ones reported for most common fruit juice (Akubor and Egbekumn 2007; Nwokocha and Akobundu, 2013). Calcium plays fundamental roles in most reactions involving phosphate transfer, believed to be essential in the structural nucleic in the structural suability of nucleic acid and intestinal absorption. Appeal (1999). A significant difference was observed in all the samples, (A, B and C).

3.2.2. Magnesium

The blend of the two juice A, (monkey kola and pineapple juice 50/50) had the higher magnesium content (10.71mg/100g) than B and C (monkey kola and pineapple juice) that had (9.30 and 9.38mg/100g) respectively. This is in line with the magnesium content of other fruit juice that ranges from (0.32 – 39.8mg/100g) as reported by Okundu *et al,* (2015)

magnesium was found to be the next highest mineral component in the study. Magnesium has reported as an activator of many enzyme systems and maintains electrical potential in nerves. A significant difference was all observed in all the samples A, B and C at ($p<0.05$).

3.3.3. Phosphorus

The phosphorus content of juice is low compared to other minerals in the study. There is no significance difference between sample B and C while there is significance difference between samples A and B, A and C. the phosphorus content of B (monkey kola) is higher than sample A (the blend). Phosphorus is needed for the growth maintenance, and repair of all tissues and cells, and for the production of genetic building blocks, DNA and RNA (According to university of Maryland Medical Centre UMMC (2017)).

3.3. Vitamin Composition

Nutrient	Samples			
	A	B	C	LSD
Vitamin A	0.13 ± 0.005^{a}	0.04 ± 0.0^{a}	0.2 ± 0.0^{a}	1.41
Vitamin C	33.35 ± 0.05^{c}	75.9 ± 0.1^{b}	118.85 ± 0.05^{a}	0.41
vitamin E	0.024 ± 0.001^{b}	0.008 ± 0.0^{c}	0.034 ± 0.0^{a}	0.004

Table 3: Vitamin Composition Of Juice Developed From Monkey Kola Juice And Its Blend

Mean with different superscript along the same row are statistically different from each other ($p\geq0.05$) A = (the blend of monkey kola juice and pineapple juice) (50/50), B = (monkey kola juice), C = (Pineapple juice the reference).

3.3.1. Vitamin A

Vitamin A content of the samples ranges from 0.04 – 0.2mg/100g. Sample C had the highest value while sample B has the lowest value. There is no significant difference among all the samples. The vitamin A content of these evaluated samples are relatively low. Vitamin A plays a critical role in maintaining healthy vision, neurological function, health skin and more (Axe, 2017).

3.3.2. Vitamin C

For vitamin C, sample C the reference sample had the highest value of 118.85mg/100g followed by sample B (monkey kola juice) 75mg/100g and then sample A (the blend) 33.35mg/100g. Sample A is in line with the vitamin C content of orange juice (63.758mk/100g) reported by Awsi and Er-Dorcus and Mahammad et al. There is significant different between all the samples. The highest value for vitamin C reported in this study agreed with literature which stated that fruits have been shown to be a good source of vitamin C. Vitamin C help in the healing of wounds.

3.3.3. Vitamin E

Vitamin E content of the studied samples ranges from 0.008 – 0.034. Sample C had the highest value while sample B had the lowest value. There is no significant difference observed between the samples. According to medical experts, vitamin E helps to slow down processes that damage cell and it is needed in trace quantity because it increases health issues such as bleeding after surgery and might increase the risk for heart failure in people with diabetes and the risk for death in people with a history of heart attack and so on.

3.4. Sensory Properties

Parameters	Samples			
	A	B	C	LSD
Taste	6.45 ± 0.67^{a}	4.9 ± 1.22^{c}	8.7 ± 0.46^{a}	0.69
Monthly feel	5.5 ± 1.02^{b}	4.8 ± 1.33^{c}	8.1 ± 0.94^{a}	0.41
Appearance	5.05 ± 1.32^{b}	5.0 ± 0.30^{b}	8.0 ± 0.84^{a}	0.79
Flavour	5.3 ± 0.84^{b}	4.7 ± 0.84^{c}	8.1 ± 0.89^{a}	0.69
General	3.6 ± 1.2^{b}	5.1 ± 1.4^{b}	8.2 ± 1.03^{a}	0.96
Acceptability				

Table 4: Sensory Properties of Juice Developed from Monkey Kola Juice and Its Blend with Pineapple Juice

Mean with different superscript along the same row are statistically different from each other ($P>0.05$) A = the blend of monkey kola juice and pineapple juice 50/50, B= monkey kola juice, C= pineapple juice the reference.

The statistical analysis revealed that there was significant difference in the taste, mouthfeel and flavour but there is a variation in appearance and general acceptability as shown in table 4. Sample C is a homemade pineapple juice which was used as control. Sample C scored 8.7 which is highest followed by sample A 6.43 which is the blend of monkey kola and pineapple juice and then sample B which is the monkey kola juice. The control which is sample C was preferred by the panelist because of the sweet taste which made it to lead in brix content. In Appearance and general acceptability, there is no significant difference between sample A and B.

In general, the sensory evaluation in which 20 panelists were used and a 9 – point hedonic scale in which 9-like extremely and 1-disluke extremely was used showed that panelist preferred sample C which is the pineapple juice used as control and sample A is the next preferable and then sample B.

4. Conclusion and Recommendation

The study was conducted to assess the physical, chemical and sensory properties of juice developed from monkey kola and its blend with pineapple juice. It was observed that the resultant juice samples had a pH range of 3.83-4.33 for samples A and C respectively. A reversed case occurred on those samples for titratable acidity with a range 0.79 – 3. 59. The highest soluble sugar was found in pineapple followed by the blend of pineapple and monkey kola. Monkey kola had the highest value for calcium while the blend of the two juices had the highest value of magnesium. Sample C had the highest value for vitamin C followed by sample B. the vitamin E content of sample B is relatively low compared to sample A and C.

All the sensory attributes of the juice were highest in the sample C (the control) and sample A is the second and then sample B. however, the low vitamin E and the low sugar content (Brix) of juice produced from monkey kola makes juice suitable to be incorporated into the diet of people with the history of heart attack and diabetes.

5. References

i. Harris A, Key J. and Silcocks B. (1991). Dietary carotene 3rd ed. Prentice Press, NY. Pp. 63 – 68.
ii. Adubofuor J. Amankwah E.A., Arthur B. S. and Appiah F. (2010). Comparative study related to physico-chemical properties and sensory qualities of tomato juice and cocktail juice produced from oranges, tomatoes and carrots. African Journal of Food Science 4(7), 427-433).
iii. Ndife, j Awogbenja D. and Zakari U. (2013). Comparative evaluation of the nutritional and sensory quality of different brands of orange juice in Nigerian market. African Journal of Food Science 7(12), 479-484.
iv. Emelike N. J. t. and Ebere C.O (2015). Effect of packaging materials, storage conditions on the vitamin C and pH value of cashew-apple (Anacardoium Occidentat L) Juice. Journal of Food and Nutrition Sciences 3(4), 160-165.
v. Richard Asare (2012). Comparative assessment of quality fruit juice from three different varieties of pineapple.
vi. Dr. Axe (2017). Health benefit of vitamin A. its sources and side effect.
vii. Muhammad S, Sargbir A.S. and Saima.M. (2013). Role of sodium benzoate as a chemical preservative in extending the shelf life of orange juice. Global Advanced Research. Journal of Food Science and Technology 2(1), 007-018.
viii. AOAC (2012). Official Method of Analysis of the Association of official Analytical Chemists, 20th ed.
ix. Awsi J. and er- Dorens M. (2012). Development and quality evaluation of pineapple juice blend with carrot and orange juice. International Journal of Scientific and Research publication, 2(8) 1-7.
x. Franke A.A., Cooney R.V., Henning S.M., and Custer L. J. (2005). Bioavailability and antioxidant effects of orange juice components in humans. Journal of Agriculture and Food Chemistry, 53(13), 5170-5178.
xi. Okudu, H.O., Ene-obong H.N. and Asumugha V.U. (2005). Chemical and Sensory properties of juice developed from two varieties of monkey kola (cola parchycarpa, cola lepidota). African Journal of food Science and Technology, 6(5), 149-155.
xii. Akubor PI, Egbekum MK. (2007) Physico-chemical properties of beverage prepared from pineapple and Sour sop juice blends. Journal of Nutritional Science. 28:201-208.
xiii. Appel LJ. (1999). Nonpharmacologic therapies that reduce blood pressure: A Fresh perspective. Clin-cardiol. 22:1111-1115.
xiv. Nwokocha W., Akobundu ENT. (2013). Nutrient Composition, Physical and Sensory properties of Orange, Pineapple and Water Melon juices. Nigerian Journal of Science 34:147-150.
xv. Ezeama CF. (2007). Food Microbiology: Fundamental and Applications. Natural Prints Ltd. Lagos.
xvi. Jay MJ. (2000). Modern Food Microbiology. (6th ed). Aspen Publishers Inc., Gaithersbung, Maryland.
xvii. Adebola, A.C. (1992). Biotechnology of Kola Improvement In: Iholtappilly, L.M., DR. Mont, M., Raji and A.W. Moore, (eds), Biotechnology; Enhancing Research on Tropical Crops in Africa.
xviii. Adebola, P.O. (2003). Genetic characterization and biosystematic studies in the genus Cola Schott and endlicher. P.H.D. Thesis Submitted to the University of Ibadon.
xix. Akinosun, FF (2010). Production and quality evaluation of juice form blend of water melon and pineapple fruits. Journal of Food Science: 2(4):54-58.
xx. Angel N., Opermann, C., Falodun, A and Udo K. (2011). Proliferative effect of five Traditional Nigerian Medicinal Plant Extracts on Human Breast and Bone cancer cell lines. Journal of Ethnopharmac .1., 137: 1003-1010.

xxi. Association of Analytical Chemist AOAC (1990). Official Method of Analysis. Association of Official Analytical Chemist AOAC (2006). Official methods of Analysis.
xxii. Baker K.F., J.L., Collins (1939). "Notes on the distribution and ecology of Ananas and Pseudananas in South America", American Journal of Botany. The Pineapple: Botany. Utilization, Cultivation, (London: Leonard Hill) J. L. 1960.
xxiii. Beauman, Francesca (2005). The Pineapple: King of Fruits, Chalto & Windus ISBN 978-0701176990 (p.82).
xxiv. Bettoni, contributions a L'etude botanique des plantes cultivees. Essai d'une monographic du genre Ananas, Annales Cient. Paraguary (2nd series)4 '(1919:250-322).
xxv. Bode H.B., Zeggel B., Silakowski B. Wenzel S.C., Reichenbich H. Muller R. (2003). Steroid Biosynthesis in Prokaryotes Identification of myoxbacterial steroid and doing of bacteria.
xxvi. Brigit Bradtke (2010). "Pineapple Growing" Tropical permaculture.com. Bromelain, University of Maryland Medical Center, Accessed 13 May 20914.
xxvii. Check, M., (2002). Three new species of Cola (Sterceliaceae) from Western Cameroon. KewBull. 57:403-415.
xxviii. Collingham, Lizzie (2006). "Carry: a Tale of Cooks and Conquerors". New York Oxford University Press. 1SNN 0-09-51724, 1-8.
xxix. Coppens d'teckenbrugge, Geo; Freddy Leal (2003). "Chapter 2: Morphology, Anatomy, and Taxonomy". In O.P. Bartholomew, R.E. Paull, and K.G. Rohrbach. The pineapple: Botany, production and uses. Wallingford UK: CABI Publishing. P. 21.I SEN.
xxx. Dictionary.reference.com "Pineapple definition/Definition of pineapple at Dictionary.com" Retrieved on 6 December, 2009.
xxxi. Duanep Bartholomew (2009). "MD 2' Pineapple Transforms, the World's Pineapple Fresh Fruit Export Industry" (PDF). Pineapple News 16:2-5. Retrieved 3 September, 2014.
xxxii. Eating to fuel fertility, Bridget Swinng, MS, ED, LD, Today's Dietition, vol. 15 No. 5 p. 38, Accessed 13 May 2014.
xxxiii. Francisa G., Kerem Z., Makkar H.P.S., Bcker K. (2002). The Biological action of spinning in animal systems.
xxxiv. Fruit of the Islands. Pittabury Magazine 39(3):92- 2008.
xxxv. Galeotti, F., Barile E. Curir P., Dolci M. and V. Lanzotti, (2008). Flavonoids from Carnation (Dianlhus caryophyilus) and their antifungal activity. Phytochem. Lett., 1:44-48.
xxxvi. Gary T. Kubota (December 24, 2009). "Maui Pineapple harvests final crop". Honolulu star Bulletin. Retrieved November, 2010.
xxxvii. Hakins, Richard (2007). James D. Dole and the 1932 Failure of the Hawaiian Pineapple Company". Hawalian Journal of History 41:149-170.
xxxviii. Healthive Mealin Copyryh (c) 2005-2016.
xxxix. Increasing Dietary Potassium. Today's Dictionary, vol. 14 No 12. P.50, Accessed 13 February 2014.
xl. Inverse associations between Serum concentrations of Zeaxanthin and other Carotenoids and Colorcatal Neoplasm in Japanese, Okuyama V., Ozasa K, Old K., Nislshino H, Funginoto S., Watenabe Y., Int'l Clin Oncol, 2013, Abstract, Accessed 13 December 2013.
xli. Katie E. F. and Thorglon R.W. (2006). The animal answer guide Johns Hopkins University Press, Baltimore, London pp.91.
xlii. Keay, R.W., Orochie, C.F.A. and Stanfield, D.P. (1964). Nigerian Trees. National Press Limited. Vol.2. P 219.
xliii. Mauseth JP (2003). Botany, an introduction to plant Biology. Boston, lomes and barlet Publisher. P. 285.
xliv. McGce H (2004). On Foods and Cooking. The Science and Love of the Kitchen. NY Scriber. P. 714.
xlv. MeKenzie, Gene (2010). A little Bit of History". Journal of Bromclind Society 60(4): 187-189.
xlvi. Mortor, Julia F (1987). "Pineapple, Ananas Comosus". Retrieved 2011-04-22.
xlvii. Ogbu JU, Essien BA, Kadurumba CH (2007). "Nutritional Value of Wild" Cola spp. (Monkey Kola) Fruits of Southern Nigeria. Nig. J, of Hort. Sci. 12:1 13-117.
xlviii. Oghenerobo V. I., Falodun A. (2013). Antrotida N. activities of the leaf extract and fractions of cola lepidota K. schum (Stercu liaceae). Nigeria. Journal of Biotechnology, 25:31-36.
xlix. Okporie E. O. (2006). Statistics for Agricultural and Biological Science, Cheston Agency Ltd. pp. 77.
l. Omono, .E., Niemcnaka N. and Ndoumou O. O. (2006). Isoenzyme variability of three cola (Cola acuminate. Palate Beauu Schott and Endlicher), germplasm in Cameroon.
li. Oxford Index-peter de la Court Vander Vourt. Oxford index. Oup.eom. Oxford University Press. Retrieved 15 December 2014.
lii. Pineapple Working Group. International Horticultural Society. Retrieved 15 August, 2010.
liii. Pineapple. Faculty.ucc.edu. retrieved (2009).
liv. Plasma and Dietary carotSnoids and the risk of prostrate: A nested case-control study, W.K, Endnum W. Dr., Schowartz SJ, Platz EA, Leitzmann M, Clinton Sk, DeGroff V, Willett WC, giovannucci E. Cancer Epidemoi Biomarkers Prev, (2004) Feb; B(2): 26-9, Abstract, Accessed 12 December 2013.
lv. Rohdes J. (2013). "It's Pineapple Season But Does your Fruit come from Hawaii" Smithsonian Intitution. Retrieved 29 December 2015.
lvi. Russet, T. A. (1955). The Kola of Nigeria and the Cameroon. Trop. Agric (Trindadl). 32:210-240.

lvii. Singh B, Gupta V, Bansal P, Singh R, Kumer P (2010). Pharmacological Potential plant used as asphrodisiaes. Int'l J. Pharm. Sci. Rev, Res. P. 104-107.
lviii. Stevenson, Jack, Exploring Scotland's Heritage: Glasgow, Clydesdate and Stirling. Her Majesty's-Stationery Office, 1995 (p.83).
lix. Sunrise, Sunset, Hawali Business 46(2):60-2000.
lx. Town, P.A. (1967). Studies on trustfulness in Cola nitida, M. Phil Thesis, Submitted to the University of Ready UK., PP. 127.
lxi. Yamamot, V. and R.B. Gaynor (2001). Therapeutic Potential of Inhibition of the NI:. Kappa B. Pathway in the treatment of Inflammation and Cancer. J. Clin. Invest., 107:135-142.