academicJournals

Vol. 7(10), pp. 355-360, October 2013
DOI: 10.5897/AJFS2013.1068
ISSN 1996-0794 ©2013 Academic Journals
http://www.academicjournals.org/AJFS

African Journal of Food Science

*Full Length Research Paper*

# Towards food security and improved nutrition in Nigeria: Taro (*Colocacia antiquorum*) grit as carbohydrate supplement in energy food drink

**Onyenekenwa Cyprian Eneh**

Institute for Development Studies, Enugu Campus, University of Nigeria, Nsukka, Enugu State, Nigeria.

Accepted 22 August, 2013

**Nigeria's population growth rates (3.2% in the late 1980s, 2.83% in the early 1990s and 3% in the mid-2000s) have been high, while subsistence farming, characterised by inadequacies, low productivity and high post-harvest losses, dictates rising food insecurity and dwindling nutrition in the country. Taro (*Colocasia antiquorum*)- a widely cultivated cocoyam, has little demand as food and is vulnerable to post-harvest rot. Towards addressing food insecurity and improving nutrition, this study investigated the potentials of taro as carbohydrate supplement in energy food drink. Chemical analyses were employed to obtain the compositions of prepared taro grit and its energy food drink prepared with sorghum malt grist. A randomly selected panel of tasters appraised the sensory qualities of the prepared taro energy food drink, while a public analyst assessed its fitness to be sold as energy food drink. Results show that the proximate percentage compositions of taro grit were 77.93% starch and 0.63% fat, among others. These were comparable with the literature values of 63-79% starch and 1.8-2.9% fat for cocoa- a popular carbobydrate supplement in common commercial energy food drinks. The malted sorghum grist had CWE value of 25.82 and HWE value of 59, which fell within the literature acceptable ranges of 16.07-26.54 (CWE) and 17.5-63.1 (HWE). The taro energy food drink was water-soluble and had similar physico-chemical characteristics and compositions to those of "Ovaltine" (a product of Cadbury Nigeria Plc), which was used as standard. The panel of tasters could not distinguish the aroma and flavour of the standard from those of the taro energy food drink, which was also adjudged suitable to be sold as energy food drink by the public analyst. It was recommended that the bench-scale production of taro energy food drink should be scaled up to pilot level with a view to commercialising it, in order to minimise post-harvest losses of taro to rot; save storage difficulties, cost and time; increase the nutritional value, presentations and demand for taro; and reduce the price to enhance the affordability of energy food drink in Nigeria.**

**Key words:** Food security, improved nutrition, post-harvest loss, Nigeria, taro, carbohydrate supplement, energy food drink.

## INTRODUCTION

The smallness of cocoyam starch grains aid digestion, and qualifies cocoyam as a composite in the manufacture of infant meals, convalescing patients requiring easily diggestible carbohydrate as a source of energy without cumbersomeness on the digestive system and stress on the metabolic process. Thus, cocoyam starch is good for peptic ulcer patients, patients with pancreatic disease, chronic liver problems, inflammatory bowel disease and

E-mail: esccha@yahoo.com or onyenekenwa.eneh@unn.edu.ng. Tel: +234-803-338-7472.

gall bladder disease (Emmanuel-Ikpemel et al., 2007).

Onwuka and Eneh (1998) reported that Nigeria is one of the leading producers of root crops, including cocoyam, which is one of the under-exploited tropical plants with promising value. Its cultivars are Tannia (*Xanthosoma*) and Taro (*Colocasia*). Widely cultivated varieties in Nigeria are *Xanthosoma sagittifollium, Colocasia esculenta* and *Colocasia antiquorum.* All three varieties are rich in easily digestible starch grains. The percentage carbohydrate fractions of taro are starch (77.9), pentosans (2.6), crude fibre (1.4), reducing sugars (0.5), dextrin (0.5) and sucrose (0.1). The starch has industrial potentialities. Taro also contains a host of mineral elements, such as calcium, phosphorus, potassium, chlorine, magnesium, sulphur, iron, copper, manganese and zinc. Besides, taro has certain medicinal values and has been used as a specialty food for potentially allergic infants and for persons suffering from gastro-intestinal disorders. The study also noted that cocyam cultivation, harvest and preparation involve less labour and fewer processes than those of other tuber crops. The demand for *C. antiquorum* as food was still poor, even though it could be boiled, baked, roasted, fried, or boiled and pounded into paste (*fufu*) for food or as soup thickener. Cocoyam flour is highly digestible, and therefore, suitable for feeding invalids, for making confectionaries and baby food.

Food and Agricultural Organisation (FAO, 2010) reported that the world total output of taro was 11.3 milliom metric tons (mmt) in 2009. Nigeria was the world leading producer of taro with 4.4 mmt, followed (with a wide margin) by China and Cameroon (1.7 mmt each), Ghana (1.5 mmt) and Papua New Guinea (0.3 mmt). All the other countries put together contributed the remaining 1.7 mmt.

But, the crop yields remain under-exploited, with vulnerability to post-harvest rot in Nigeria, where population growth rates have been high at 3.2% in the late 1980s, 2.83% in the early 1990s and 3% in the mid-2000s. The character of agricultural practice, fraught with subsistence farming, low productivity and high post-harvest losses, dictates rising food insecurity. Nigeria's national average figure for household difficulty satisfying food need was 12.7% in 2005, with the Southest geo-political zone recording the highest figure of 25.4% (Eneh, 2011a).

The UNDP Human Development Index (HDI) Report 2010 ranked Nigeria 142nd out of 169 countries. Mauritius- another African country was ranked 72nd and has life expectancy of 72.1 years, while Nigeria has 48.4 years. Other African countries that ranked ahead of Nigeria were Tunisia (81st), Algeria (84th), Gabon (93rd), Egypt (101st), Namibia (105th), South Africa (110th), Morrocco (114th), Equatorial Guinea (117th), Cape Verde (118th), Congo (126th), Sao Tome and Principe (127th), Kenya (128th), Togo (129th), Ghana (130th), Cameroon (131st), and Benin Republic (134th). In terms of life expectancy, Togo (63.3 years), Benin Republic (62.3 years), Ghana (57.1 years) and Cameroon (51.7 years) were also better than Nigeria, the most populous country in sub-Sahara Africa, the region with the lowest HDI indicators. The population of the extremely poor Nigerians rose from 6.2 to 38.7 %, while non-poor decreased from 72.8 to 31% between 1980 and 2010 (NBS, 2012).

Absolute poverty, which measures not only low income, malnutrition, poor health, clothing, shelter, and lack of education, is reflected in the low living standards of Nigerians. The average daily calorie intake per capita hardly exceeds 2,000 in Nigeria (Eneh, 2011b). Food insecurity and malnutrition are, therefore, issues. National infant and maternal mortality rates are still high at 105 per 1,000 and 800 per 100,000 live births, respectively (Ugwu, 2009).

Availability and affordability of energy food drink will contribute to good nutrition and food security. Standard energy food drinks are made with malted cereal, which is rich in carbohydrate (energy source), proteins (amino acids), many vitamins and enriched with minerals. Cocoa (grit) is the widely used supplementary carbohydrate (energy) source. The rich carbohydrate and nutritional value of malt is released when the malt interacts with heat and water. Common energy food drinks contain more than 50% natural malt. Energy value is about 413 kcal/100 g. The average market price is N1.25/g for canned products and N1.15/g for sachet products (personal observations and market survey).

Sorghum, a cereal cultivated in commercial quantity in Nigeria has been malted and used for beer brewing (Onwuka and Eneh, 1998). It is suspected that sorghum malt can be applied to energy food drink production and that taro can replace cocoa as a carbohydrate supplement in the drink. This would minimise post-harvest losses of taro to rot; save storage difficulties, cost and time; increase the nutritional value, presentations and demand for taro; and lower the price to enhance affordability of energy food drinks.

So far, much of taro harvest is wasted in Nigeria and other developing countries to technological backwardness characterising the developing countries (Jhingan, 2007), which hampers food preservation and processing. Globally, about one-third of annual food production (1.3 billion tons) goes to post-harvest losses.

In West Africa, about 50% of perishable food commodities are lost after harvest. Post-harvest food loss is estimated at 25% per year in Nigeria (Aworh, 2008). It militates against food security and availability (Mrema and Rolle, 2002). If not addressed, a high-calorie and nutritious crop harvest can rot to deplorable waste, thereby limiting the supply and increasing the cost of food. As a post-harvest loss, rot wastes food, human efforts, farm inputs, livelihoods, investments and scarce resources. Enhancing food processing and preservation will minimise post-harvest losses in developing countries, where seasonal food shortages and nutritional deficiency diseases are still a major concern (World Resource Institute, 1998).

Emmanuel-Ikpemel et al. (2007) observed that physical, physiological and pathological factors are responsible for the post-harvest rot of cocoyam tubers. *Fusarium solani*, *Botryodiplodia theobromae*, *Rhizopus stolonifer*, *Aspergillus Niger* and *Sclerotium rolfsii* participate in the spoilage. The high respiratory activity of the corm also causes spoilage of cocoyam.

The need to address food insecurity and improved nutrition for the growing population of Nigerians motivated this study. Specifically, it investigated the potentials of *C. antiquorum* grit as a carbohydrate supplement in energy food drink produced with sorghum malt.

## MATERIALS AND METHODS

The study was conducted between December 2005 and August 2012 in Enugu, Enugu State, Nigeria. Enugu State is one of the 5 States of the Southeast geo-political zone of Nigeria. This zone is a leading producer of cocoyam among the 6 zones in the country. Sorghum grain is produced in commercial quantity in neighbouring Kogi and Benue States. *C. antiquorum* and white sorghum variety (*Sorghum vulgare)* were bought from the Ogbete Market, Enugu, the capital city of Enugu State and the erstwhile headquarters of the defunct Eastern Region. The Vitamins Mixture Pack was also bought from a licensed veterinary shop in the city. The standard energy drink (*'*Ovaltine*'*, a product of Cadbury Nigeria Plc) was bought from an accredited distributor for Cadbury Nigeria Plc in Enugu city. The chemicals (all of analytical reagent grade), apparatus and equipment were available in the laboratory of the Department of Medical Biochemistry, College of Medicine, Enugu Campus, University of Nigeria, Nsukka.

### Preparation of taro grit

The procedure adopted by Onwuka and Eneh (1996) was followed.

### Malting of sorghum grains and preparation of sorghum malt grist

The procedure adopted by Onwuka and Eneh (1998) was followed.

### Determination of carbohydrate content of taro grit

The method adopted by Onwuka and Eneh (1996) was followed.

### Determination of reducing sugars content of taro grit

The reducing sugars content of taro grit was determined by the method adopted by Onwuka and Eneh (1998).

### Determination of ether extract of taro grit

The ether extract of taro grit was determined according to the method adopted by Onwuka and Eneh (1996).

### *Determination of fibre content of taro grit*

Fibre content of taro grit was determined by the method adopted by Onwuka and Eneh (1998).

### Nitrogen and protein content determination in taro grit

The nitrogen and crude protein in taro grit were determined by the method adopted by Onwuka and Eneh (1996).

### Cold water extract (CWE) of sorgum malt Grist

The Onwuka and Eneh (1998) method was adopted.

### Hot water extract (HWE) of sorgum malt Grist

The Onwuka and Eneh (1996) method was adopted.

### Preparation of taro energy food drink

Several ratios of taro grit and sorghum malt grist were tried out to select one with sensory evaluation that approximated that of the commercial standard. To 97 g of this mixture was added 3 g of vitamins from the Vitamins Mixture Pack to get the taro energy food drink.

### Water-solubility test for taro energy food drink

Fifteen grams of the taro energy food drink was stirred in 100 ml of water at room temperature (30°C) to see if it would dissolve.

### Analysis of the taro energy food drink

The prepared taro energy food drink was sent to a public analyst for assessment and remarks.

### Sensory evaluation of taro energy food drink

Using a commercial energy food drink ('Ovaltine' by Cadbury Nigeria Plc) as the standard, which was set at 100%, the prepared taro energy food drink was evaluated by staff and students at the University of Nigeria, Enugu Campus, whose consent had been sought and obtained. Aroma and flavour were the sensory attributes evaluated.

## RESULTS AND DISCUSSION

Steeping and couching the sorghum grains resulted in sweet grains. This was in agreement with earlier findings. reproted that steeping and couching grains increased the moisture content to 25 to 40% to induce germination and to develop or activate enzyme systems important in subsequent commercial uses of the malt. Sweetness and softness indicated good seedlings modifications, characteristic of food preparations contain-ing malts and malt extracts. Kilning dried the green malt to 4-6% moisture content to stop further growth of the seedling. It also

**Table 1.** Proximate analysis of taro grit (%).

| | Nitrogen | Crude protein | Fibre | Ether extract | Reducing sugars | Total carbohydrate |
|---|---|---|---|---|---|---|
| Taro grit | 1.38 | 8.13 | 2.69 | 0.63 | 33.55 | 77.93 |

**Table 2.** Sensory evaluation of taro energy food drink.

| Aroma | Rating with standard | Flavour | Rating with standard |
|---|---|---|---|
| Beverage-like | 99.98% | Beverage-like | 84.68% |

The term, 'beverage,' used by tasters, refers to commercial energy food drinks in Nigeria made from cocoa and malt.

resulted in the development of a control-lable degree of colour. The Maillard reaction during kilning resulted in the formation of amino acid-carbonyl compounds, which underwent further transformation to yield the desired flavour, colour and aroma of the incompletely charac-terized compounds known as the melanoidins. In a hydrolysis process, the enzyme (dias-tase) or acid con-verted the carbohydrate (starch) to sweet fermentable sugars (e.g. maltose, a dissacharide), as respresented in the equation below:

$$\underset{\text{(starch)}}{2C_6H_{10}O_5 + H_2O} \xrightarrow[\text{(acid or diastase)}]{\text{Hydrolysis}} \underset{\text{(maltose, a sugar)}}{C_{12}H_{22}O_{11}}$$

The heat-dried *C. antiquorum* turned brown. After milling, the touch, odour and appearance of the taro grit agreed with earlier findings. Onwuka and Eneh (1998) reported that, on heating, a mixture of sugar and amino acids rapidly darkened, liberating carbon (IV) oxide ($CO_2$) gas and water. Heating treatment introduced desired colour, aroma and flavour into the carbohydrate substance by removal of water to make it friable. This process is also called caramelisation. Where dark colour is desired, special attention is given to the maintenance of the autolysis period with sufficient temperature. 'Stewing' favours darker products. The resulting colouring and flavouring materials, called melanoidins, are water-soluble colloidal materials of characteristic aroma and flavor, and weakly acidic. Having the power to act as oxidation-reduction buffers, and to enhance the stability of the product, they are representatives of the class of stabilising reductones.

The odour and appearance of the taro grit and its energy food drink persisted beyond five (5) years of storage in a tightly covered bottle at normal room tem-perature, while the touch was lost after one-year storage under the same conditions. Foods loose one charac-teristic or the other after a period of storage, hence regulatory agencies require that 'expiry' and 'best before' or 'use before' dates should be inscribed on food packages to guide consumers. Therefore, the 'best before' or 'use before' date for taro energy food drink should reflect one year gap from manufacturing date.

The cold water extract (CWE) value is a percentage measure of ready-formed soluble material in malt. The CWE of the sorghum malt grist was 25.82, which fell within the acceptable range of 16.07-26.54 (Onwuka and Eneh, 1998). The hot water extract (HWE) value is a measure of all materials brought into water solution by enzymic action in malt grist. The HWE value of the sorghum malt grist was 59, which fell within the acceptable range of 17.5-63.1 (Onwuka and Eneh, 1998). Like the the standard, the taro grit, sorghum malt powder and taro energy food drink were water-soluble. Table 1 shows the data on the proximate analyses of taro grit.

The total carbohydrate content of taro grit (77.93%) was comparable to carbohydrate contents of cocoa (63-79%) quoted in common literatures (Onwuka and Eneh, 1998, 1996), showing that taro has the potential of providing the carbohydrate supplement in energy food drink. The fat content (ether extract) of taro grit (0.63 %) was also comparable to the fat contents of cocoa (1.8-2.9%) quoted in literatures (Onwuka and Eneh, 1998, 1996), showing that taro is not only suitable for carbohy-drate supplement, but also much less disposed to rancidity than cocoa. The percentage reducing sugars content (33.55), nitrogen (1.38) and crude protein (8.13) of taro grit fell within acceptable range for carbohydrate supplement in energy food drink, when compared with cocoa's 63-7% (starch) and 1.13-2.10% (fat) (Onwuka and Eneh, 1998, 1996).

Table 2 shows the sensory evaluation data of the taro energy food drink. The aroma (99.98%) and flavour (84.68%) were excellent. The report of the public analyst on the analyses of taro energy food drink is shown on Table 3. It is subdivided into physical inspection, compo-sition and remarks. Each parameter was compared with that of the universal standard. All parameters for physical inspection of the taro energy food drink were found to be similar to those of the universal energy food drinks. While the physical appearance and colour of taro energy food

**Table 3.** Report on the analysis of taro energy food drink.

| Parameter | | Taro energy food drink | Universal standard |
|---|---|---|---|
| **Physical Inspection** | | | |
| 1. | Appearance | Brown coloured grit | Brown to deep amber coloured grit |
| 2. | Odour | Similar to energy food drink | Pleasant |
| 3. | Colour | Brown | Brown to deep amber colour |
| 4. | Texture | Crispy | Crispy |
| **Compositions** | | | |
| 1. | Energy | 1,733 kJ (411 kcal) /100 g | 1,501 (356 kcal) - 1,792 kJ (425 kcal)/100 g |
| 2. | Protein | 9.97 % | 8-13% |
| 3. | Carbohydrate | 82.18 % | 74-85% |
| 4. | Sugars | 47.78 % | 42-49% |
| 5. | Fat | 2.99 % | 2.5-11% |
| 6. | Fibre | 2.10 % | 1.3-3.7% |
| 7. | | | |
| 8. | Minerals | Sodium (0.3 %)<br>Calcium (0.1 %)<br>Phosphorus (0.25 %)<br>Magnesium (0.13 %)<br>Iron (0.15 %)<br>Zinc (0.06 %) | Sodium (0.2-0.35%)<br>Calcium (0.08-0.14%)<br>Phosphorus (0.18-0.3%)<br>Magnesium (0.1-0.22%)<br>Iron (0.09-0.2%)<br>Zinc (0.03-0.09%) |
| 9. | Vitamins/100 g | A (0.8 mg)<br>$B_1$ (1.8 mg)<br>$B_2$ (1.7 mg)<br>$B_6$ (1.5 mg)<br>$B_{12}$ (0.001 mg)<br>D (0.006 mg)<br>E (3.6 mg)<br>Pantothenic acid (15 mg)<br>Follic acid (0.004 mg)<br>Niacin (22.9 mg) | A (0.5-1.3 mg)<br>$B_1$ (1.2-2.2 mg)<br>$B_2$ (1.1-2.3 mg)<br>$B_6$ (0.9-2.1 mg)<br>$B_{12}$ (0.0007-0.008 mg)<br>D (0.001-0.009 mg)<br>E (2.9-4.2 mg)<br>Pantothenic acid (9-18 mg)<br>Follic acid (0.001-0.009 mg)<br>Niacin (22-23.1 mg) |

drink were brown, the universal standard is brown to dark amber. The odour of the taro energy food drink was found to be as pleasant as the odour of the universal standard. Like the universal standard energy food drink, the texture of the taro energy food drink was crispy.

The compositions of the taro energy food drink compared favourably with those of the universal energy food drinks. The energy value of the taro energy food drink was 411 kcal, against 356-425 kcal universal range of values.

The protein content was 9.97%, against 8-13% universal standard. The total carbohydrate content was 82.18%, against 74-85% universal range of values. The sugars content was 47.78%, against 42-49% universal standard. The fat content was 2.99%, against 2.5-11% universal range of values. The fibre content was 2.1%, against 1.3-3.7% universal standard.

The minerals content also compared favourably at 0.3% against 0.2-0.35% universal standard for sodium, 0.1% against 0.08-0.14% universal range of values for calcium, 0.25% against 0.18-0.3% universal standard for phosphorus, 0.13% against 0.1-0.22% universal range of values for magnesium, 0.15 % against 0.09-0.2% universal standard for iron, and 0.06% against 0.03-0.09% universal range of values for zinc. Also, the vitamin contents compared favourably with those of the universal values. The taro energy food drink had 0.8 mg of vitamin A, against 0.5-1.3 universal standard; 1.8 mg vitamin $B_1$, against 1.2-2.2 mg universal range of values; 1.7 mg of vitamin $B_2$, against 1.1-2.3 mg universal standard; 1.5 mg of $B_6$, against 0.9-2.1 mg universal range of values; 0.0001 mg $B_{12}$, against 0.0007-0.008 mg universal standard; 0.006 mg of D, against 0.001-0.009 mg universal range of values; 3.6 mg of E, against 2.9-4.2 mg universal standard; 15 mg pantothenic acid, against 9-18 mg universal range of values; 0.004 mg follic acid, against 0.001-0.009 mg universal standard; and 22.9 mg niacin, against 22-23.1 mg universal range of values. Hence, it was remarked that taro energy food drink was “suitable to be sold as energy food drink”.

Malted cereals also contain water-soluble vitamins, including vitamin B, ascorbic acid, pantothenic acid, biotin, niacin, nicotineamide, riboflavin, anuerin, among other nutrients that enrich energy food drink preparations. A good quality energy food drink is high in carbohydrate content with easily digestible sugars to produce energy, and low fat content to minimize rancidity. These qualities were contributed to the taro energy food drink by the taro grit, since taro is rich in digestible carbohydrate (77.93% comparable to 63-79% carbohydrate content of cocoa) and has lower fat content (0.63%) than cocoa (1.8-2.9%).

## Remarks

The product anlysed, which is similar in appearance and composition to commercial energy food drinks, is deemed suitable to be sold as energy food drink.

## Conclusions and recommendations

Based on the results obtained, taro (*C. antiquorum*) variety of the cocoyam has high potentials in terms of its suitability and availability to supplement the carbohydrate content of energy food drink. This bench-scale study needs to be scaled up to pilot level, with a view to commercialising the production of taro energy food drink. This would enhance the nutritional value of taro, increase its availability and varieties, increase its demand for food, minimise its post-harvest losses to rot, save storage difficulties and time, and reduce the price to enhance affordability of energy food drinks.

## REFERENCES

Aworh OC (2008). Using Food Science and Technology to Improve Nutrition and Promote National Development. In Robertson GL, Lupien JR (eds.), International Union of Food Science and Technology, Chapter 3.

Emmanuel-Ikpemel CA, Eneji CA, Essiet U (2007). Storage Stability and Sensory Evaluation of Taro Chips Fried in Palm Oil, Palm Olein Oil, Groundnut Oil, Soybean Oil and Their Blends. Pak. J. Nutr. 6(6): 570-575.

Eneh OC (2011a). Crippling poverty amidst corporate social actions: a critique of peripheral corporate community involvement in the Niger Delta region of Nigeria. Asian. J. Rural Dev. 1(1): 1-20.

Eneh OC (2011b). Nigeria’s Vision 20:2020 - Issues, Challenges and Implications for Development Management. Asian. J. Rural Dev. 1(1):21-40.

FAO (Food and Agricultural Organisation) (2010). Top Taro Producers - 2009. Available at http://www.faostatunfoodandagriculturalorganisation Retrieved September 19, 2012.

Jhingan ML (2007). The Economics of Development and Planning. 39ed. Delhi: Vrinda Publications (P) Ltd.

Mrema CG, Rolle SR (2002). Status of the postharvest sector and its contribution to agricultural development and economic growth. Proceedings of the 19th JIRCAS International Symposium on value-addition to agricultural products. Ibaraki, Japan. pp. 13-20.

NBS (National Bureau of Statistics) (2012). Nigerian Poverty Index 2010 Report. Available at http://www.nigerianpovertyprofilereport2010.NBS.pdf Accessed, 5/14/2012.

Onwuka ND, Eneh OC (1996). The Cocoyam, *Xanthosoma sagittifollium*, as a Potential Raw Material Source for Beer Brewing. Plant Foods Hum. Nutr. 49(4):283-293.

Onwuka ND, Eneh OC (1998). The Potential of Cocoyam (Colocesia) in Stout-Beer Brewing. J. Sci. Technol. 4:79-86.

Ugwu DS (2009). Effects of Oil Exploration on Agriculture and Natural Resources in the Niger Delta Region of Nigeria. Sustain. Hum. Dev. Rev. 1(2):117-130.

World Resource Institute (1998). Disappearing food: How big are postharvest losses? Available at http://www.wri.org/publication/content/8386.