African Journal of Biotechnology Vol. 7 (24), pp. 4576-4580, 17 December, 2008
Available online at http://www.academicjournals.org/AJB
DOI: 10.5897/AJB08.758
ISSN 1684–5315 © 2008 Academic Journals

Full Length Research Paper

The potential of *Terminalia catappa* (Almond) and *Hyphaene thebaica* (Dum palm) fruits as raw materials for livestock feed

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Accepted 3 October, 2008

The physicochemical analysis of sun dried mesocarp of fruits of *Terminalia catappa* and *Hyphaene thebaica* was investigated. It is aimed at sourcing alternative local raw materials that contain required nutritional composition for production of livestock feed. This study revealed that the mesocarp of the fruits of *T. catappa* and *H. thebaica* contain 8.10- 12.65% ash, 84.93- 89.25% carbohydrate, 0.37- 0.95% oil, 238- 316 mg/g glucose contents and anti-nutritional factor value of 1.30 mg/g for *T. catappa* and 8.30 mg/g for *H. thebaica* tannin content. The protein contents of 0.1 and 0.01% are very low but their calorific values of 3434.5 and 3655.9 kcal/kg for *T. catappa* and *H. thebaica*, respectively, are high. The metal ion concentrations of Ca (45.58-245.10 mg/100 g), Mg (96.35-236.45 mg/100 g), Fe (5.14- 47.96 mg/100 g), Cu (0.10-0.38) and Zn (0.45 -0.62) in these mesocarp seemed adequate enough to provide metal ions for biochemical activities of livestock if the mesocarp of the fruits are used in livestock feed formulation. In addition, the presence of low level of tannin may form the basis for anti–inflammatory activity in the feed.

Key words: Livestock, feed formulation, metal ions, macronutrients, *Terminalia catappa*, *Hyphaene thebaica.*

INTRODUCTION

The development of good immune system in humans contributes extensively to freedom from frequent sickness and illness, resulting in good health. The consumption of high quality food helps in achieving this goal. The quest for high quality food has led to increase in global production of animal and fish. As a result, animal husbandry which include poultry, pig rearing, cattle fattening and dairy cattle are being developed rapidly and this has consequently led to an increase in demand for livestock feedstuff (Fetuga and Tewe, 1985; Konpiang, 1994).

The ever increasing competition between man and animals for available grains (Egbunike et al., 2002) and the inadequate production of farm crops to meet the needs of man and his livestock (Babatunde et al., 1990) have led to search for other sources of raw materials which are not in competition with human diet. Researchers, for many years, have reported the replacement of grains and fish protein in production of feed meals (Babatunde et al., 1975; Ahmad et al., 2006; Hassan et al., 2007). For instance, substitution of fish meal up to 33% with processed mucuna grains in poultry ration resulted in producing heavier and less breakable eggs (Camara et al., 2003). Replacement of maize has been successfully achieved with millet and sorghum (Ojewola and Scholarstica, 2006; Artkinson et al., 1975). Long ago root crops like yam, cassava and cocoyam had been proposed as potential raw materials for animal feeds (Yoshida et al., 1966; Muller et al., 1975) but some of them could not be used for one reason or the other. Cassava is high in carbohydrates but low in protein, fat and mineral contents. It has a caloric value that is comparable to that of maize for all kinds of livestock and poultry feeds but its cyanide toxicity affected its acceptability. The low protein content has been augmented by compounding the cassava roots with soybean which contains 44 - 48% protein to yield desired livestock feed meal ration with adequate nutrients (Eke et al., 2000). In a simi-

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lar study, Muller et al. (1975) discovered that the nutritive component of mixture of 85% cassava and 15% soybean meal was similar to that of maize. Apart from non-suitability of cassava in compounding feed rations due to low protein content and other nutrients, its cyanide toxicity had been reported to cause human ataxic neuropathy, goiter and cretinism in rat (Ekpechi, 1973; Ermans et al., 1973). The usage of *Terminalia catappa* and *Hyphaene thebiaca* mesocarp had not been found in literature as source of raw materials for feed ration formulation. However, some studies on medicinal properties of their leaves, roots and fruits have been reported. In traditional medicine, *T. catappa* leaf, bark and fruit are used in treating dysentery, rheumatism, cough and asthma. The fruit is also helpful in the treatment of leprosy and headaches and the leaves are specifically used in getting rid of intestinal parasites, treatment of eye problems, wounds, and liver problems (Kirtikar and Basu, 1991; Corner, 1997; Manjunath, 1976). Scientifically, the fruit has demonstrated anti-diabetic activity (Nagappa et al., 2003) and the leaves, anti-sickling activity (Moody et al., 2003). The chloroform and methanol extracts of the bark and root displayed strong antimicrobial activities (Pawar and Pal, 2002). The fruits contain beta carotene, cyanidin-3-glucoside, brevifolin, carboxylic acid, ellagic acid and tannins (Manjunath, 1976; Soepadmo, 1998). *T. catappa* commonly called tropical almond, wild almond, India almond, sea almond, etc, belongs to the family of *Combretacea*. It is widely grown in tropical region of the world as an ornamental tree. The world's production of this fruits is about 700,000 tons annually. The sweet variety, *Prunus delcis vardulas*, is the source of edible almond nuts. The nut (seed) which contains high quantity of essential amino acids is a good source of dietary protein, with crude protein content of 25.81% (Ezeokonkwo and Dodson, 2004). It is also rich in esters of palmitic and linoleic acids.

The second raw material source *H. thebaiaca,* (Dum palm) fruit belongs to *palmae* family which is distinguished from all other palms of West Africa by its forking stem. Each dum palm fruit is about 7.5 × 5 cm in size and its mesocarp, smell and taste like ginger; hence it is referred to as ginger bread in some places. It grows in the Sahel in the hot Savanah between 12-18 N from Senegal to Northern Nigeria, Chad, Zaire and North East Africa. The young leaves are readily eaten by livestock while the old leaves are bitter and unpalatable. The fruit is glubose-quadrangular about 6 x 5 cm with a shinny orange-brown to deep chestnut skin (epicarp). The mesocarps in some are not edible but of others very palaable, highly aromatic and sweet with the taste of ginger. When eaten, it serves as febrifuges and parasite expellant (Burkill, 1984). The presence of estrone in the kernel and pollen grains have been reported (Amins and Paleologou, 1973). The chloroform extract of the fruit improve spermatic count of male rats at low concentrations (Hetta and Yassin, 2006b) but could decrease it at high concentrations (Hetta et al., 2005). The aqueous extract of *H. thebaica* fruits has been reported to have significant antifungal properties (Irobi and Adedayo, 1999).

However it is known that maize is a major constituent of feed all over the world. It forms the standard (100) against which other cereal grains are compared (Atteh, 2002). Its dietary energy is high but the protein content is low. Fish, protein concentrates and soybeans are used to beef up this deficiency. Research efforts are been made to look for other sources of energy producing farm produce for livestock feed formulation to reduce the stiff competition between man and his livestock in the consumption of maize. Fetuga and Tewe (1985) examined the chemical composition and nutritive value of some crop residues from processing industries that could be utilized as feed meal component. Some of these by-products include wheat bran, rice bran and husks, brewer's grains, molasses, sugar cane tops, cocoa pods and discarded cocoa bean shell, peels of yam, cassava, plantain, pineapple, orange, lemon and grape wastes.

Though, meals like fish, soybean, bone and blood meals are usually added to the livestock feeds of low protein and fat contents to improve the protein contents and specifically amino acid content, there is need to ascertain composition of essential metal ions in alternative raw material for livestock feed in addition to protein, amino acids and fatty acids. The knowledge about composition of metal ions in the raw materials for livestock feeds helps immensely to beef up the immune system of livestock, thereby preventing diseases. In this study we examine the physicochemical properties of *H. thebaica* (Dum palm) and *T. catappa* (Almond) fruits which we are proposing as raw materials for com-pounding livestock feeds.

Thus the shortage of quality animal feeds, particularly in developing countries of Africa due to seasonal variation and non-availability of qualitative pasture (Fasuya, 2005) has necessitated this study.

MATERIALS AND METHODS

Sample collection and pre-treatment

The mature ripe *T. catappa* fruits were collected by hand picking from the trees at the University of Ilorin, Ilorin, Kwara State in the central part of Nigeria in February 2006. The trees are being used in the institution as ornamental plants and for provision of shade. The mature ripe *H. thebaica* fruits were collected from Gashua, Yobe state, in the North Eastern part of Nigeria in August 2006 also. The two fruits were identified at the Department of Botany, University of Ilorin, Ilorin, Nigeria. Each of the fruits mesocarp was scooped with knife and sun dried in the open for 7 days and stored in clean plastic containers prior analysis. Commercial feed used for metal ion comparison with our proposed raw materials were bought from commercial outlet where poultry farmers purchase feed in Ilorin, North Central and Ibadan, Western parts of Nigeria.

Proximate analysis of fruits mesocarp

The proximate analysis was done according to the standard procedures (AOAC, 1990). The dry matter (DM) content was determined by a representative 2 g sample in an oven at 105°C for 24 h repeatedly until a constant weight was obtained. Crude oil was exhaustively soxhlet extracted from 2 g sample with n-hexane for 6 h. The ash content was determined by incinerating 2 g sample in a muffle furnace at 550°C until fully burnt to obtain ash of constant weight. The nitrogen was determined by micro-kjeldahl method as described by Pearson (1976) and the crude protein content calculated as N% x 6.25. Carbohydrate was determined by difference. The energy values were derived by multiplying the amounts of protein, carbohydrate and oil by the factors of 4, 4 and 9 (k cal) respectively (EEC, 1990). A representative anti-nutritional factor (tannin) of the two fruit mesocarps was determined using Nahm method (1992).

Determination of metal ions in the mesocarp fruits

Metal ions (Ca, Mg, Fe, Cu and Zn) contents in the samples were determined using the method of Association of Official nalytical Chemists (AOAC, 1990) with the aid of atomic absorption spectrophotometer (Buck Scientific, 205 Model) using hollow cathode lamp of the elements and a fuel rich flame (air-acetylene). Standard and digested samples were aspirated and the mean signal responses were recorded at each of the element's respective wave lengths. A blank determination was also conducted.

Statistical analysis of data

Statistical analysis of the physicochemical data was carried out using ky-plot with the aid of one way ANOVA and Bartlett's Test for homogeneity of variance. Significant differences were used to separate means at p<0.05.

Table 1. Physicochemical properties of air- dried almond and dum palm fruit mesocarps.

Parameter	*T. catappa*	*H. thebaica*
Ash (%)	12.65 ± 0.04[a]	8.10 ± 0.06[b]
Oil (%)	0.37±0.15[a]	0.95 ± 0.18[a]
Moisture (%)	1.95 ± 0.40[a]	1.70 ± 0.41[a]
*Carbohydrate (%)	84.93 ± 1.36[a]	89.25 ± 0.98[a]
Protein (%)	0.10 ± 0.01[a]	0.01± 0.001[b]
Glucose (mg/g)	316.00 ± 2.65[a]	238.00 ± 1.98[b]
Tannin (mg/g)	1.30 ± 0.01[a]	8.30 ± 0.01[b]
Calorific calue (kcal/kg)	3434.5 ±2.28[a]	3655.9 ±2.77[b]

Values are ± standard deviation for duplicate data.
Parameter on the same row with same alphabet is not significantly different at 95% confidence limit.
*Determined by difference.

Table 2. Metal ion contents (mg/100 g) of *Terminalia catappa, Hyphaene thebaica* and reference growers and layers marsh.

Sample	Ca	Mg	Fe	Cu	Zn
T. catappa	245.1	236.45	5.14	0.378	0.62
H. thebaica	45.58	96.35	47.96	0.102	0.45
Growers marsh	3.21	6.72	0.33	< 0.01	3.75
Layers marsh	nd	nd	nd	0.48	4.54

nd = Not determined.

RESULTS AND DISCUSSION

The physicochemical properties and metal ions content of dried mesocarp of almond and dum palm are presented in Tables 1 and 2, respectively, while comparison of proximate composition of maize, sorghum and proposed farm by-products are presented in Table 3. The moisture contents of the dried mesocarp of both *T. catappa* and *H. thebaica* were found to be 1.95 and 1.70%, respectively (Table 1). This implies that their dry matter content is high which is desirable for feed materials. Their moisture contents is far lower than that of *Albizia lebbeck* pods, a source of feed composition for livestock which contains 15% moisture content (Hassan et al., 2007). The low moisture contents of the dried fruit mesocarps help reduce microbial activity and give a longer time of storage for feed prepared from these fruits (Hassan et al*.,* 2005b). Light yellow and yellow liquids were obtained for *T. catappa* and *H. thebaica,* respectively. The oil content of the fruits mesocarp is low, 0.37% for *T. catappa* and 0.95% for *H. thebaica* compared to maize 4.18%, sorghum 3.55% and millet 3.92 (Olomu, 1995; Ojewola and Scholarstica, 2006); their possession of essential fatty acids is of great importance. The sweet smell and lack of off-flavour smell or hexanal smell show that the oil is stable and not easily rancid even after two months of extraction (Eriksson, 1987). Also, this characteristic pleasant odour of ester of acids stimulates appetite for the livestock. The carbohydrate content obtained by difference was found to be as high as 84.93 and 89.25% for *T. catappa* and *H. thebaica,* respectively. This high carbohydrate content represents good dietary energy source and is in the same range with grains like maize, sorghum and millet (Ojewola and Scholarstica, 2006). The protein content is low and as usually done for grains with low protein content; the feed can be fortified with protein supplements like fish, blood, bone meals and protein concentrates. The high glucose content of these fruits (316 mg/g for *T. catappa* and 238 mg/g for *H. thebaica*) are indicative that feed made from them have high calorific value. Their calorific values are calculated to be 3434.5 and 3655.9 kcal/kg for *T. catappa* and *H. thebaica,* respectively. High carbohydrate content provides energy for the livestock to survive high biochemical activities taking place within their system especially in the tropics.

The anti-nutritional factors as represented by tannin content exist in low level. For *T. catappa* it is 1.30 mg/g and for *H. thebica,* 8.30 mg/g. This is however advantageously since at low concentration tannins play the role of anti-inflammatory agent. The fractions of tannin and flavonoids found in ethylacetate extract as well as saponin in methanol extracts of *H. thebaica* fruit mesocarp have been reported to be responsible for the antifungal and antibacterial activities of the extracts (Irobi and Adedayo, 1999; Dosumu et al., 2006). Also, reduced

Table 3. Proximate composition of some grains and our proposed feed raw materials.

Fraction	Maize	Sorghum	*T. catappa*	*H. thebaica*
Gross energy (kcal/kg)	4182.0	3539.0	3434.5	3655.9
Protein (%)	11.20	10.85	0.10	0.01
Ash (%)	1.50	2.21	12.65	8.10
Fat/oil (%)	4.18	3.55	0.37	0.95
Moisture (%)	12.38	11.26	1.95	1.70

inflammation was observed when induced acute and chronic ear edema in mice was treated topically with application of ethanol and chloroform extracts of *T. catappa* leaves (Fan et al., 2004). Thus, the low concentration level of tannins recorded and low saponin and flavonoids from literature in the fruit mesocarp may not pose any health problem but instead aid fighting of diseases (Ojewola and Scholarstica, 2006).

Statistical analysis revealed that there was no significance difference in the oil, moisture and carbohydrate content of the two potential raw materials for livestock feed formulation. However, significance difference existed for ash, protein, glucose content and calorific value.

The ash content obtained from dry *T. catappa* and *H. thebica* fruit mesocarps fall within 8.10 – 12.65% which indicate the presence of substantial metal ions and minerals. The concentrations of the metal ions in these dry fruit mesocarps of *T. catappa* are found to be 245.10, 236.45, 5.14, 0.38, and 0.62 mg/100 g for Ca, Mg, Fe, Co, and Zn metal ions, respectively. However, with exception of Fe (47.96 mg/100 g), the metal ions of Ca, Mg, Cu and Zn present in *H. thebica* exhibited low values when compared to those of *T. catappa* as indicated in Table 2. Apart from Ca and Mg metal ions with high values, the metal ions are within the range previously reported as adequate for livestock feed (McDowell, 1985; Hassan et al., 2007). These values are comparable to those of growers and layers marsh purchased from commercial outlets as shown in Table 2. The values are adequate to meet the requirement for growth, reproduction and resistance to diseases (McDowell, 1985). In commercial growers' marsh, bought at Ibadan and Ilorin, the concentration of Ca, Mg, Fe, Cu, and Zn investigated using the same method of analysis for our fruits gave 3.21, 6.72, 0.30, <0.01, and 3.75 mg/100 g, respectively while 4.54 and 0.48 mg/100 g were obtained for Zn and Cu respectively for layers marsh. Metals ions are important constituents of feeds, therefore *H. thebaica* (Dum palm) and *T. catappa* (almond) from renewable natural source of plant origin could serve as good sources of metal ions.

It is known that certain metal ions are essential for normal biochemical functioning and development of organs (Pier and Bang, 1980; Martins 2002). Calcium has been reported to be effective in building of skeletal structures and muscle functioning while magnesium is important in the ionic balance and enzyme co-factors. Iron is a component of haemoglobin and is essential for vitamin B synthesis. The presence of zinc in organism also helps in the synthesis of tryptophan, an essential amino acid. Copper is the main metal component of the respiratory pigments. It has also been observed that when dietary intake of copper is inadequate in vertebrates, it leads to serious deficiency diseases such as anemia and graying of hair. Thus, livestock feeds that contain these metal ions would contribute some essential metal ions for metabolic activi-ties in livestock and in turn in humans. Our proposed raw materials have these metal ions in adequate quantities (FAO, 1990).

Table 3 shows the proximate composition comparison of maize, sorghum, *T. catappa* and *H. thebaica.* The caloric energy supplied by the grains and *T. catappa* and *H. thebaica* is comparable. Maize has a value of 4182.0 kcal/kg, sorghum 3539.0 kcal/kg, *T. catappa* 3434.5 while *H. thebaica* has 3655.9 kcal/kg. The protein content of *T. catappa* and *H. thebaica* is very low, high protein fortification should be considered if our raw materials are to be used in livestock feed formulation. The oil quantity in the mesocarp is low, though the fatty acid composition was not determined; the sweet smell of the oil is an attractant to consumption by livestock. The fat/oil content (0.37-0.95%) of our proposed raw materials for livestock is found to be lower than those of maize (4.18%) and sorghum (3.55 %). However, their ash content of our proposed raw materials is higher than that of maize and sorghum (Table 3). The amount of these major components could be ranked in increasing order as follows; oil < moisture < mineral content < carbohydrate.

Conclusion

It can be concluded that the mesocarp of *T. catappa* and *H. thebaica* fruits contain major nutrients of carbohydrate, oil and metal ions necessary for biochemical activities of vertebrate organs. Hence, the mesocarps of the fruits which are farm by-products could be good sources of raw materials or supplements for livestock feed formulations. Anyway, before this feed can be incorporated into livestock feed, the amino acids profile of the protein and the fatty acid composition of the oil should be investigated. Also, presence or otherwise of other anti-nutritional factors should be determined.

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