

***Colocasia esculenta* (L.) Schott as an alternative energy source in animal nutrition**

Adejumo I.O. *, Babalola T.O., Alabi O.O.

Department of Animal Science, Landmark University, Omu-Aran, Nigeria

ABSTRACT (ARIAL, BOLD, 11 FONT, LEFT ALIGNED, CAPS)

Aims: This review was undertaken to examine the potential use of **taro** (*Colocasia esculenta*) and its by-products as an alternative energy source for feeding animals.

Previous study: Previous studies indicated that raw sundried taro meal contained about **87.90-90.57** percent dry matter, about 4.93-7.07 crude protein, 2.70-3.90 percent crude fibre, 2956 – 2966 (Kcal/kg) metabolisable energy. Taro is not a common food for man, and its use in animal nutrition is however limited by the presence of anti-nutritional factors such as oxalates, saponin, phytate, and tannins.

Conclusion: Taro (*Colocasia esculenta*) is a less well known source of energy which is not in great demand for human food. The use of taro (*Colocasia esculenta*) in animal nutrition should be maximally exploited as a way of reducing the competition between man and animals for maize utilization, since the quantity of grains produced in tropical Africa is not sufficient to feed the increasing human population. Heat treatment and protein supplementation are however recommended for optimal use of *Colocasia esculenta* in animal nutrition.

Keywords: alternative, animal, energy, nutrition, taro

1. INTRODUCTION

The two most important nutrients required in animal nutrition are energy and protein. In Nigeria, energy and protein constitute about three-quarters of the total cost of formulated feed (Olomola *et al* 2008). Cost of feeding in livestock production in Nigeria is rather too exorbitant (Tewe 1997; Babayemi and Bankole 2009). High cost of feeding livestock is attributed to low production of grains as well as increase in human population. **Low production of grains has resulted in competition between human and animals for feed ingredients.** This, if continued unchecked will pose a threat to global food security. Food security is defined to exist as situation when all the people at all times have physical, social, and economic access to sufficient, safe and nutritious food which meets their dietary needs (FAO 2002). Some of the factors stressing food security are poverty, climate change, animal pests and diseases (FAO 2005; Nnadi *et al* 2010). Poverty is the cause and consequence of food insecurity (Akinyele 2009). Maize which is a food security crop is in high demand by human and animals. Maize is the major cereal that is involved in animal nutrition, representing the main energy source and constituting about 60 percent of the diet of **monogastric** animals (Teguia *et al* 2007).

Many livestock farmers in Nigeria feed agro industrial by-products to their animals due to high cost of conventional feed ingredients (Iyayi *et al* 2003). Agro industrial by-products are however of low nutritive value, and non-conventional feed stuffs such as taro can be fed in place of agro-industrial by-products which are of low nutritive value. Two types of crops that share the name cocoyam are *Xanthosoma sagittifolium* and *Colocasia esculenta* (Dotsey 2009). Taro has been said to have the potential of being used in ruminant nutrition (Babayemi and Bankole 2009). It has been fed to snails (Okon *et al* 2012); fish (Aderolu *et al* 2009); pigs (Agwunobi *et al* 2002, Ngo and Preston 2010); and poultry (Abdulrashid and Agwunobi 2009; Ologhobo and Adejumo 2011; Adejumo and Ologhobo 2012).

The use of taro in animal nutrition is however limited by the presence of anti-nutritional factors such as tannins, saponins, oxalates, phytates, and hydrocyanide (Abdulrashid and Agwunobi 2009; Olajide *et al* 2011). Processing techniques such as boiling or cooking, soaking, ensiling and drying have been shown to reduce the effects of these anti-nutritional factors on the animals (Onu and Madubuike 2006; Olajide *et al* 2011; Adejumo and Ologhobo 2012). Taro is not a too popular crop and its potential not fully utilized. The paper therefore aims to review the potential values and constraints to the increased use of taro (*Colocasia esculenta*) and its by-products in animal nutrition.

2. PRODUCTION OF TARO

Cocoyam in most African countries is mainly cultivated by small-scale farmers (Onwueme and Charles 1994). Taro has not received pronounced research attention to enhance its production and utilization potentials despite its nutritional composition, resulting in under utilization of the potential for the development of value added cocoyam products (Goenaga and Heperly 1990; Palapala *et al* 2005).

Taro is an herbaceous plant which belongs to the family Araceae. The most available members of the family are taro (*Colocasia esculenta*) and *Xanthosoma sagittifolium*. The top world producers of taro (*Colocasia esculenta*) are Nigeria, China, Cameroon, and Ghana. The world's total production of taro in 2011 was 9,532,427 tons while more than 74 percent of the total production comes from Africa (FAOSTAT 2012). Nigeria being the leading world's producer of taro produced more than 27 percent of the total world's production in 2011. Cocoyam yields vary from place to place. The major determinants of the variation are the conditions under which they are cultivated.

3. NUTRITIVE VALUES OF TARO

Colocasia esculenta is one of the six most important root and tubers crops worldwide (Jennings 1987). Corms of cocoyam are known to supply easily digestible starch, substantial amount of protein, thiamine, vitamin C, riboflavin, niacin, as well as significant amounts of dietary fiber (Niba 2003). Leaves of taro are eaten as vegetable by human, having β carotene, iron, protein, vitamins and folic acid which protects against anemia (FAO 1990; Sukamoto 2003; AFRIS 2004). The major nutrient in taro corms is dietary energy (FAO 1990; Jirarat *et al* 2006; Ndabikunze *et al* 2011). The most abundant minerals in *Colocasia esculenta* are potassium, phosphorus, magnesium, and calcium (Ndabikunze *et al* 2011). Nutritional composition of roots and tubers vary from place to place depending on climatic conditions, variety of crop cultivated, as well as soil conditions (FAO 1990). The result of the study carried out by Abdulrashid and Agwunobi (2009) revealed that taro meal contained 7.87% crude protein, 31% dry matter, 4.75% crude fiber, and 3214.91 Kcal/kg metabolisable energy on dry matter basis. The result of proximate analysis carried out on *Colocasia esculenta* by Ogunlakin *et al* (2012) showed that *Colocasia esculenta* contained 89.53-90.57% dry matter, 4.93-5.17% crude protein, 0.50-0.57% ether extract, 2.70-2.97% crude fiber, 78.7-79.0% carbohydrate and 2.47-2.87% ash content on dry matter basis. *Colocasia esculenta* in its raw form is toxic. The toxin is however destroyed by processing techniques such as cooking, soaking, ensiling and drying (Onu and Madubuike 2006; Olajide *et al* 2011;

Ogunlakin *et al* 2012). Cooking has however been shown to reduce the protein content of cocoyam (Onu and Madubuike 2006; Olajide *et al* 2011). Ogunlakin *et al* (2012) noted that the physico-chemical properties of sun-dried sample of *Colocasia esculenta* were more acceptable than oven-dried and cabinet-dried samples, having greater values in most physico-chemical properties considered. It was said that sun-dried sample retained the best starch structure.

4. ANTI-NUTRITIONAL FACTORS IN TARO

Colocasia esculenta is a cheaper carbohydrate source than grains (Adejumo and Bamidele, 2012; Onu and Madubuike, 2006). It has low production cost, high caloric yield per hectare and are not easily susceptible to pests and disease attack. Its major limitations in its use in animal nutrition are storage and the presence of anti-nutritional factors such as tannins, saponins, phytates, oxalates it contains. Some anti-nutritional factors serve as defense mechanisms against pests and diseases. For example, oxalates have been observed to play defense role in plant as well as storage reserve for calcium (Smith 1982).

A toxicant is a substance which under practical circumstances can impair some aspect of animal metabolism and produce adverse biological or economic effects in animal product (Udeybir *et al* 2008). Anti-nutritional factors are however described as substances in the diets which by themselves or their metabolic products arising in the system interfere with the feed utilization, thereby reducing production or affect the health of the animals. Toxicants can be classified based on their chemical properties of effect of their utilization on nutrients as alkaloids, glycosides (such as saponins, cyanogens), phenols (gossypol, tannins), mycotoxins, metal binding (oxalates) and proteins (protease inhibitors and haemoglutinins).

4.1 SAPONINS

Saponins are known with distinctive foaming characteristics. They are bitter and are known to reduce feed palatability. Saponins have been reported to cause bloat in ruminants (Udeybir *et al* 2008). Bloat is a distension of the rumen resulting from the inability of the animal to get rid of gases produced in normal processes to rumen fermentation.

4.2 TANNINS

Tannins are a high molecular weight polyphenolic substances. There are hydrolysable and condensed tannins. Hydrolysable tannins are easily hydrolysed in water, acids, enzymes or bases to yield gallotannins and ellagitannins (Udeybir *et al* 2008). Condensed tannins on the other hands are flavonoid polymers of flavonol. They are astringent in nature and bind with protein, thereby reducing protein availability to animals. They are known to inhibit cellulose digestibility as well as reduction of digestion of crude fiber. Soaking and cooking have however been reported to reduce tannin content (Udeybir *et al* 2008). Moderate level of tannins (usually less than 4%) in forages has been reported to improve growth and milk yield while levels exceeding 6% of the diet has been observed to reduce growth rate and milk production in ruminants.

4.3 OXALATES

Hang and Preston (2010) reported that oxalate levels were higher in petioles of taro cocoyam than in leaves. The authors reported further that sun-drying, soaking, cooking, and ensiling reduced the concentration of oxalate. The effects were however most pronounced for cooking and ensiling. Oxalates are known to precipitate calcium in the gastrointestinal tract as insoluble calcium oxalate. Diets containing oxalate have been shown to cause calcium deficiency in cattle, which consequently resulted in poor milk production and growth. Fresh leaves of taro contain about 3.08% of oxalate on dry matter basis (Pheng *et al* 2008). The authors reported that the process of ensiling the taro leaves was more effective than sun-drying in reducing the content of calcium oxalate.

4.4 PHYTATE

Phytate has been observed to decrease the utilization of several mineral elements such as phosphorus, calcium, and magnesium, being the most abundant minerals in *colocasia esculenta* by forming insoluble compounds which are excreted in faeces. Supplementation of enzyme phytase is recommended in poultry to make phosphorus available (Udeybir *et al* 2008).

5. USE OF *COLOCASIA ESCULENTA* IN ANIMAL NUTRITION

The result of the study by Chhay *et al* (2007) revealed an **apparent reduced digestibility** for pigs fed diets containing ensiled taro leaves as against the higher values recorded in the findings of Pheng *et al* (2008). The variation was however attributed to the differences in fibre level of the energy sources used in the studies. Studies on boiled taro cocoyam in the diets of weaned pigs carried out by Agwunobi *et al* (2002) revealed that there was no significant difference in feed intake, weight gain and feed efficiency between the diets containing boiled taro corms. It was exactly opposite with the diets contained unboiled taro, especially at levels more than 50% replacement of maize. In another study by Ngo and Preston (2010) feed intake, rate of live weight gain and feed conversion ratio were poorest in pigs fed fresh taro leaves and stem, better responses were obtained for pigs fed cooked taro leaves and stem, while the best results were obtained for those fed ensiled taro leaves and stem.

Babayemi and Bankole (2009) observed that the energy content and proximate metabolisable energy content of *Colocasia esculenta* corms indicated that *Colocasia esculenta* is a potential useful energy supplement in ruminant feeding. The result of a study carried out by Okon *et al* (2012) showed that sun-dried taro meal can replace maize up to 50% in the diet of *Achatina achatina* without adverse effects on reproductive traits. **The authors however recommended that inclusion of taro in the diet of animals at higher levels should be processed.** Aderolu *et al* (2009) fed one hundred and forty juveniles of *Clarias gariepinus* with diets containing graded levels of raw and differently processed cocoyam corms at 25% and 50% substitution levels for maize meal. The result showed the mean weight gain, relative growth rate and specific growth rate had the highest value recorded for the control followed by those fed diet containing 25% boiled cocoyam. The least value was however recorded for those fed diet containing 50% of fermented cocoyam. The authors reported significant lower values for all blood parameters recorded in the raw cocoyam meal diet. The result indicated that fish fed with boiled cocoyam diet gained higher weight than those fed raw cocoyam diet.

Adejumo and Ologhobo (2012) reported that boiling of *Colocasia esculenta* resulted in an improvement over the raw in broiler finishers fed differently processed *Colocasia esculenta*, having no adverse effects on **hematological** parameters of the birds. Abdulrashid and Agwunobi (2009) recommended that proper processing of *Colocasia esculenta* meal will effectively replace maize in the diets of broiler finishers at 25% for raw sundried taro cocoyam meal and 50% for boiled sundried taro. **It has also been observed that silage made from taro leaves and petioles replaced up to 60 % of rice bran in diets for growing ducks without any decrease in performance, growth and with positive effects on carcass quality (Nguyen Tuyet Giang *et al*, 2009). Also, boiled sun-dried taro cormels had been reported to replace up to 50 % of maize (8.4 % of the total diet) in the diets of Japanese quails (Okon *et al*, 2007).**

However, Ologhobo and Adejumo (2011) concluded that boiled peeled sundried taro meal can replace maize in the diets of broiler finishers at 100% inclusion level, without any significant adverse effects on the performance characteristics of the birds.

6. COST IMPLICATION OF USING TARO COCOYAM IN ANIMAL NUTRITION

Energy sources, especially maize are the most important and expensive feedstuffs, which account for about 50-55% of poultry diet (Afolayan *et al* 2002). High cost of maize has been observed to result from declining production condition and keen competition for its use by man and animals (Agbede *et al.*, 2002; Hamzat *et al* 2003). Hence, in seeking replacement for maize in animal nutrition, cost implication of the use of the potential non-conventional feedstuffs should be considered. The results of the previous studies revealed that taro is a cheap source of carbohydrates in animal nutrition (Onu and MAdubuire, 2006; Adejumo and Bamidele, 2012). Aderolu *et al* (2009) also concluded that there was economic decrease in price of feed with the inclusion of cocoyam meal.

7. CONCLUSION

Taro (*Colocasia esculenta*) is a less well known source of energy which is not in great demand for human food. The use of taro (*Colocasia esculenta*) in animal nutrition should be maximally exploited as a way of reducing the competition between man and animals for maize utilization, since the quantity of grains produced in tropical Africa is not sufficient to feed the increasing human population. Heat treatment and protein supplementation are however recommended for optimal use of *Colocasia esculenta* in animal nutrition.

COMPETING INTERESTS

Authors declare that there are no competing interests.

AUTHORS' CONTRIBUTIONS

All authors contributed to the work.

References

- Abdulrashid M, Agwunobi LN. Taro cocoyam (*Colocasia esculenta*) meal as feed ingredient in poultry. Pakistan Journal of Nutrition, 2009; 8(5):668-673
- Aderolu AZ, Lawal MO, Oladipupo MO. Processed cocoyam tuber as carbohydrate source in the diet of juvenile African catfish (*Clarias gariepinus*). European Journal of Scientific Research, 2009; 35(3):453-460
- Adejumo IO, Bamidele Oladeji. Cost implication of differently processed wild cocoyam [*Colocasia esculenta* (L.) Schott] as feed ingredient in broiler finishers. The International Journal's Research Journal of Science & IT Management, 2012; 1(10):20-23
- Adejumo IO, Ologhobo AD. Haematological response of broiler finishers fed differently processed taro cocoyam (*Colocasia esculenta* [(L.) Schott]. Agricultura Tropica Et Subtropica, 2012; 45(3):112-116
- Afolayan GG, Olorode BR, Uko JO, Junaidu AU, Fanimio AO. The replacement of value of maize bran for maize in broiler finisher diets. Proc. 27th Ann. Conf. Anim. Sci. of Nig. (ASAN), Abeokuta, 2002; 91-93
- AFRIS. Animal Feed Resources Information Systems. Updated from B. Gohl (1981).

240 Tropical Feeds, Foods and Agriculture Organization, 2004.
 241 <http://www.fao.org/ag/AGa/agap/FRG/AFRIS/DATA/527.htm>
 242 Agbede JO, Ajala K, Aletor VA. Influence of Roxazyme G. supplementation on
 243 the utilization of sorghum dust-based diets for broiler chicks. Proc. 27th Ann. Conf.
 244 NSAP, Akure, 2002; 105-108
 245 Agwunobi LN, Awukam PO, Cora OO, Isika MA. Studies on the use of
 246 *Colocasia esculenta* (taro cocoyam) in the diets of weaned pigs. Tropical Animal
 247 Helath and Production, 2002; 34:241-247
 248 Akinyele Isaac O. Ensuring and nutrition security in rural Nigeria: an assessment of the
 249 challenges, information needs, and analytical capapcity. International Food Policy
 250 Research Institute, Nigeria, 2009.
 251 Babayemi OJ, Bankole MA. Nutrient value and in vitro gas production of African
 252 wild cocoyam (*Colocasia esculentum*). African Journal of Food, Agriculture, Nutrition
 253 and Development, 2009; 9(1):593-607
 254 Chhay TY, Khieu Borin, Preston TR, Mea Sokveasna. Intake, digestibility and
 255 nitrogen retention by growing pigs fed ensiled or dried taro (*Colocasia esculenta*)
 256 leaves as the protein supplement in basal diets of rice bran/broken rice or rice
 257 bran/cassava root meal. Livestock Research for Rural Development, 2008; 19(9),
 258 <http://www.lrrd.org>
 259 Dotsey P. The use of cocoyam, cassava and wheat flour composite in the production of
 260 rock cakes, HND dissertation, Cape Coast Polytechnic, Cape Coast, Ghana, 2009;
 261 1:7-40
 262 FAO. Roots, tubers, plantain and bananas in human nutrition. Effect of processing on
 263 nutritive values. Food and Agriculture Organization of the United Nations, Rome,
 264 1990.
 265 FAO. The state of food insecurity in the world, 2001. Food and Agriculture Organization
 266 of the United Nations, Rome, 2002.
 267 FAO. Impact of climate change, pests and diseases on food security and poverty
 268 reduction. 31st session of the committee on World Food Security, Food and
 269 Agriculture Organization, Rome, 2005.
 270 Food and Agriculture Organization of the United Nations FAOSTAT (2012).
 271 <http://faostat3.fao.org/home/index.html#DOWNLOAD>, retrieved on March 22, 2013
 272 Geonaga R, Hepperly P. Flowering, pollen and seed viability and artificial
 273 hybridization of tanniers (*Xanthosoma spp*). J. Agri. Univer. Puerto Rico. 1990;
 274 74(3):253-260
 275 Hamzat RA, Tihamiyu AK, Raji AM. Effect of dietary inclusion of kola pod husk

276 (KPH) on growth performance of West African Dwarf (WAD) goats. Proc. 28th Ann.
 277 Conf. NASP, Ibadan, 2003; 271-273
 278 Hang DT, Preston TR. Effect of processing taro leaves on oxalate concentrations as
 279 using the ensiled leaves as a protein source in pig diets in Central Vietnam.
 280 Livestock Research for Rural Development, 2010; 22(68) from
 281 <http://www.lrrd.org/lrrd22/4/hang22068.htm>
 282 Iyayi EA, Okoruwa VO, Babayemi OJ, Busari AA, Peters OF. Livestock
 283 production pattern of agro pastoralists in peri-urban centres of Southwest Nigeria.
 284 Nigerian Journal of Animal Production, 2003; 30(1):87-92
 285 Jennings DL. Starchy crops In: CRC Handbook of Plant Science in Agriculture. Volume
 286 2 (Edited by Christie B.R.) CRC Press Inc. Boca Raton, Florida, USA, 1987; pp 137-
 287 143
 288 Jirarat T, Sukruedee A, Pasawadee P. Chemical and physical properties of flour
 289 extracted from taro *Colocasia esculenta* (L) Schott grown in different regions of
 290 Thailand. Sci. Asia, 2006; 32:279-284
 291 Ndabikunze BK, Talwana HAL, Mongi RJ, Isa-Zacharia A, Serem AK, Palapala V,
 292 Nandi JOM. Proximate and mineral composition of cocoyam (*Colocasia esculenta* L.
 293 and *Xanthosoma sagittifolium* L.) grown along the Lake Victoria Basin in Tanzania
 294 and Uganda. African Journal of Food Science, 2011; 5(4):248-254
 295 Nguyen Tuyet Giang, Preston TR, Ogle B. Effect on the performance of common ducks of
 296 supplementing rice polishings with taro (*Colocasia esculenta*) foliage. Livestock
 297 Research for Rural Development, 2009; 22 (10)
 298 Nnadi FN, Chikaire J, Ajaero C. Impact of climate change on food security and
 299 poverty reduction. Animal Production Research Advances, 2010; 6(1):20-24
 300 Ngo Huu Toan, Preston TR. Taro as a local feed resource for pigs in small scall
 301 household condition. Livestock Research for Rural Development, 2010; 22(8).
 302 <http://www.lrrd.org>
 303 Niba LL. Processing effects on susceptibility of starch to digestion in some dietary
 304 starch sources. Int.J.Food.Sci. Nutr., 2003; 54:97-109
 305 Ogunlakin GO, Oke MO, Babarinde GO, Olatunbosun DG. Effect of drying
 306 methods on proximate composition and physic-chemical properties of cocoyam
 307 flour. American Journal of Food Technology, 2012; 7(4):245-250
 308 Okon B, Ibon LA, Nsa EE, Ubua JA. Reproductive and growth traits of parents
 309 and F1 hatchings of *Achatina achatina* (L.) snails under mixed feeding regime with
 310 graded levels of swamp taro cocoyam (*Cyrtosperma chamissonis*) and pawpaw
 311 leaves (*Carica papaya*). Journal of Agricultural Science, 2012; 4(11):289-298
 312 Okon BI, Obi MB, Ayuk AA. Performance of quails (*Coturnix coturnix japonica*) fed graded

313 levels of boiled sun-dried taro cocoyam (*Colocasia esculenta*) as a replacement for
 314 maize. Agricultural Journal, 2007; 2 (6): 654-657
 315

316 Olajide R, Akinsoyinu AO, Babayemi OJ, Omojola AB, Abu AO, Afolabi KD.
 317 Effect of processing on energy values, nutrient and anti-nutrient components of wild
 318 cocoyam (*Colocasia esculenta* (L.) Schott) corm. Pakistan Journal of Nutrition, 2011;
 319 10(1):29-34

320 Ologhobo AD, Adejumo IO. Effects of differently processed (*Colocasia esculenta*
 321 / (L.) Schott) on growth performance and carcass characteristics of broiler finishers.
 322 International Journal of AgriScience, 2011; 1(4):244-248

323 Olomola OO, Babayemi OJ, Akinsoyinu AO. Performance characteristics and
 324 nitrogen utilization of pregnant West African dwarf goats fed groundnut cake, urea
 325 and rumen epithelial wastes in cassava flour and citrus pulp-based diets. Tropical
 326 and Subtropical Agro Ecosystems, 2008; 8(1):61-67

327 Onu PN, Madubuike FN. Effect of raw and cooked wild cocoyam (*Caladium*
 328 *bicolor*) on the performance of broiler chicks. Agricultura Tropica Et Subtropica,
 329 2006; 39(4):268-271

330 Onwume IC, Charles WB. Cultivation of cocoyam in: Tropical root and tuber
 331 crops. Production, perspective and future prospect. FAO Plant Production and
 332 Protection Paper 126, Rome, 1994; pp 139-161

333 Palapala V, Talwana H, Nandi JOM, Sereme AK, Ndabikunze BK. Evaluation
 334 of prospects and constraints to sustainable cocoyam (*Colocasia esculenta*)
 335 production in Lake Victoria Crescent. A project report, 2005.

336 Pheng Buntah, Ogle RB, Preston TR, Khieu Borin. Digestibility and nitrogen
 337 balance studies in pigs fed diets with ensiled taro (*Colocasia esculenta*) leaves as
 338 replacement for fish meal. Livestock Research for Rural Development, 2008; 20
 339 (supplements).

340 Smith DL. Calcium oxalate and carbonate deposits in plant cells, In: The Role of
 341 Calcium in Biology System. L.J. Aughilori and A.M. Tuffet-Anghilori (eds.) CRS Press,
 342 Boca Raton Florida, 1982; 253-261

343 Sukamoto LA. Development of early maturing and leaf blight resistant cocoyam
 344 (*Colocasia esculenta*) (L.) Schott) with improved taste. Proceedings of final research
 345 coordinated meeting organized by the joint FAO/IAEA division of nuclear technique
 346 in food agriculture held in Pretoria, South Africa, 2003; pp 19-23

347 Teguia A, Telefo PB, Fosto RG. Growth performance, organ development and

348 blood parameters of rats fed graded level of steeped and coned taro tubers
 349 (*Colocasia esculenta* var *esculenta*) meal. Livestock Research for Rural
 350 Development, 2007; 19(6). <http://lrrd.cipav.org.co/lrrd19/6/tegu19076htm>
 351 Tewe OO. Sustainability and Development Paradigms from Nigerian Livestock
 352 Industry. Inaugural lecture, University of Ibadan, Nigeria, 1997.
 353 Udeybir SC, Niranjana PS, Sanjay Kumar. Handbook of General Animal Nutrition.
 354 Global Media Publisher, 2008; pp 267-276
 355
 356

Table 1: selected taro producers

Countries	Production (tonnes)	Percentage of world's total	Percentage of Africa's production
Nigeria	2,593,860.00	27.21%	36.67%
China	1,754,100.00	18.40%	24.80%
Cameroon	1,470,000.00	15.42%	20.78%
Ghana	1,354,000.00	14.20%	19.14%
Japan	153,500.00	1.61%	2.17%
Egypt	119,379.00	1.25%	1.69%
Rwanda	185,964.00	1.95%	2.63%
Thailand	76,700.00	0.80%	1.08%
Gabon	55,000.00	0.58%	0.78%
Liberia	16,900.00	0.18%	0.24%

Source: UN FAO's FAOSTAT (2012)

Table 2: nutrient composition of taro

Parameters	Raw oven dried	Raw sundried	Raw cabinet-dried	SWCC	CWCC	FWCC
Dry matter (%)	90.57	88.42-89.53	89.87	88.06	88.64	87.90
Crude protein (%)	5.17	4.93-7.07	5.07	6.56	6.13	7.44
Crude fiber (%)	2.97	2.70-3.90	2.83	3.75	3.55	3.45
Ether extract (%)	0.57	2.47-2.93	0.50	2.86	2.76	2.63
Ash (%)	2.87	0.50-1.10	2.77	0.95	0.75	0.88
Carbohydrate (%)	79.00	73.43-78.93	78.70	73.90	75.46	73.50
ME (Kcal/kg)	NA	2958.34	NA	2943.70	2966.82	2956.52

SWCC= soaked taro; CWCC= cooked taro; FWCC= fermented taro

Source: Olajide *et al.* (2011);

Ndabikunze *et al.* (2012)

Table 3: chemical characteristics of taro leaves

Parameters	Ensiled taro leaves	Dried taro leaves
Dry matter (%)	18.30-22.60	92.20
As % in dry matter		
Crude protein (%)	25.90-26.30	26.70
Crude fiber (%)	17.10	15.20
Organic matter	8.30-8.53	8.70
Calcium oxalate	0.11	1.10

Source: Chhay *et al.* (2007);

Pheng *et al.* (2008)

Table 4: Mineral contents (mg/100g DM) of *Colocasia esculenta* and *Xanthosoma sagittifolium*

Mineral content	<i>Xanthosoma sagittifolium</i>	<i>Colocasia esculenta</i>
Potassium	908.25	715.39
Phosphorus	207.50	134.30
Copper	0.63	0.19
Iron	4.54	3.48
Zinc	2.72	4.32
Manganese	1.55	3.68
Calcium	110.17	68.67
Magnesium	90.62	83.76
Sodium	23.98	13.18

Source: Ndabikunze *et al.* (2011)

Table 5: chemical composition of differently processed taro leaves

Processing	Crude				
	Dry	protein	Crude		Oxalates
	matter (%)	(%)	fiber (%)	Ash (%)	(mg/100g)
Fresh leaves	13.70	25.30	11.40	10.50	760.00
Drying by sunlight	88.40	25.60	11.30	13.30	600.00
Soaking	17.20	25.60	11.50	10.50	570.00
Cooked	9.60	25.60	11.30	10.40	360.00
Ensiled	17.00	25.30	11.00	10.50	350.00

Source: Hang and Preston (2010)

Table 6: Residual anti-nutritional factors in differently processed taro cocoyam

Parameters	Raw taro	Cooked taro	Soaked taro	Fermented taro
Phytate (g/100 gDM)	1.01	0.26	0.08	0.05
Oxalate (g/100 gDM)	0.53	0.28	0.21	0.14
Hyrolysable tannin (g/100 gDM)	0.13	0.05	0.04	0.04
Condensed tannin (g/100 gDM)	0.28	0.22	0.18	0.16
Saponin (g/100 gDM)	0.31	0.16	0.22	0.18
Hydrocyanide (mg/kg)	17.13	7.30	7.50	7.20

Source: Olajide *et al.* (2011)