

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

Abstract

Feed accounts for 60 – 70 percent of the total cost of livestock production. This review was undertaken to examine the potential use of wild cocoyam (*Colocasia esculenta*) and its by-products as an alternative energy source for feeding animals. Previous studies indicated that raw sundried taro cocoyam meal contained about 87-90 percent dry matter, about 4.93-7.07 crude protein, 2.70-3.90 percent crude fibre, 2956 – 2966 (Kcal/kg) metabolisable energy. Taro cocoyam is not a common food for man. Its use in animal nutrition is however limited by the presence of anti-nutritional factors such as oxalates, saponin, phytate, and tannins. Processing techniques such as sun-drying, cooking, ensiling and soaking have been reported to improve the nutritive value of taro cocoyam. Taro cocoyam when properly processed and effectively supplemented with minerals and protein can be used as alternative energy source in animal nutrition.

Keywords: alternative, animal, energy, nutrition, taro cocoyam

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, which consequently resulted in keen competition between human and animals for feed ingredients, especially grains. Food, being a basic requirement of life for the survival of man has become deficient. 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 (Tegui *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. Non-conventional feed stuffs such as cocoyam can be fed instead. Two types of crops that share the name cocoyam are *Xanthosoma sagittifolium* and *Colocasia esculenta* (Dotsey 2009). Taro cocoyam 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 cocoyam in animal nutrition is however limited by the presence of anti-nutritional factors such as tannin, saponin, 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 cocoyam 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 cocoyam (*Colocasia esculenta*) and its by-products in animal nutrition.

Production of taro cocoyam

Cocoyam in most African countries is mainly cultivated by small-scale farmers (Onwueme and Charles 1994). Cocoyam generally 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).

Cocoyam is an herbaceous plant which belongs to the family Araceae. The most available members of the family are taro cocoyam (*Colocasia esculenta*) and *Xanthosoma sagittifolium*. The top world producers of taro cocoyam (*Colocasia esculenta*) are Nigeria, China, Cameroon,

and Ghana. The world's total production of taro cocoyam in 2011 is 9,532,427 while more than 74 percent of the total production comes from Africa (FAOSTAT 2012). Nigeria being the leading world's producer of taro cocoyam 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.

Nutritive vales of taro cocoyam

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 cocoyam 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 cocoyam 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 cocoyam meal contained 7.87% crude protein, 4.75% crude fiber, and 3214.91 Kcal/kg metabolisable energy. It was however reported that raw sundried taro cocoyam contained 31% dry matter, 7.87% crude protein, 4.75% crude fibre, 0.75% ether extract, 3214.91Kcal/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 physic-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.

Anti-nutritional factors in taro cocoyam

Colocasia esculenta is reported to be a cheaper carbohydrate source than grains and other tuber crops (Obioha 1972). 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 tannin, saponin, phytate, oxalate 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).

Saponin

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 eructate gases produced in normal processes to rumen fermentation.

Tannin

Tannin is a high molecular weight polyphenolic substance. 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 activity 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 tannin (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.

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 cocoyam contain about 3.08 (% in dry matter) of oxalate (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.

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).

Use of *Colocasia esculenta* in Animal Nutrition

The result of the study by Chhay *et al* (2007) revealed a decreased apparent 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 cocoyam corms. It was exactly opposite with the diets contained unboiled taro cocoyam, 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.

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

176

177 Adejumo and Ologhobo (2012) reported that boiling of *Colocasia esculenta* resulted in an
 178 improvement over the raw in broiler finishers fed differently processed *Colocasia esculenta*,
 179 having no adverse effects on haematological parameters of the birds. Abdulrashid and Agwunobi
 180 (2009) recommended that proper processing of *Colocasia esculenta* meal will effectively replace
 181 maize in the diets of broiler finishers at 25% for raw sundried taro cocoyam meal and 50% for
 182 boiled sundried taro cocoyam. However, Ologhobo and Adejumo (2011) concluded that boiled
 183 peeled sundried taro cocoyam meal can replace maize in the diets of broiler finishers at 100%
 184 inclusion level, without any significant adverse effects on the performance characteristics of the
 185 birds.

186

187 **Cost Implication of Using Taro Cocoyam in Animal Nutrition**

188 Energy sources, especially maize are the most important and expensive feedstuffs, which account
 189 for about 50-55% of poultry diet (Afolayan *et al* 2002). High cost of maize has been observed to
 190 result from declining production condition and keen competition for its use by man and animals
 191 (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 result of study carried out by Onu and Madubuike (2006) revealed that cocoyam is a cheap source of carbohydrates in animal nutrition. The authors affirmed that the result on economic production showed that cooked wild cocoyam diets were more profitable. The result of this finding is similar to what is obtained for *Colocasia esculenta* (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.

Conclusion

Taro cocoyam (*Colocasia esculenta*) is a less well known source of energy which is not in great demand for human food. The use of taro cocoyam (*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.

References

- Abdulrashid M. and Agwunobi L.N. (2009). Taro cocoyam (*Colocasia esculenta*) meal as feed ingredient in poultry. Pakistan Journal of Nutrition, 8(5):668-673
- Aderolu A.Z., Lawal M.O., Oladipupo M.O. (2009). Processed cocoyam tuber as carbohydrate source in the diet of juvenile African catfish (*Clarias gariepinus*). European Journal of Scientific Research, 35(3):453-460
- Adejumo I.O. and Bamidele Oladeji (2012). 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, 1(10):20-23
- Adejumo I.O. and Ologhobo A.D. (2012). Haematological response of broiler finishers fed differently processed taro cocoyam (*Colocasia esculenta* [(L.) Schott]. Agricultura Tropica Et Subtropica, 45(3):112-116
- Afolayan G.G., Olorode B.R., Uko J.O., Junaidu A.U. and Fanimio A.O. (2002). The replacement of value of maize bran for maize in broiler finisher diets. Proc. 27th Ann. Conf. Anim. Sci. of Nig. (ASAN), Abeokuta, 91-93
- AFRIS, 2004. Animal Feed Resources Information Systems. Updated from B. Gohl (1981).

- 224 Tropical Feeds, Foods and Agriculture Organization.
225 <http://www.fao.org/ag/AGa/agap/FRG/AFRIS/DATA/527.htm>
226 Agbede J.O., K. Ajala and V.A. Aletor (2002). Influence of Roxazyme G. supplementation on
227 the utilization of sorghum dust-based diets for broiler chicks. Proc. 27th Ann. Conf.
228 NSAP, Akure, 105-108
229 Agwunobi L.N., P.O. Awukam, O.O. Cora and M.A. Isika (2002). Studies on the use of
230 *Colocasia esculenta* (taro cocoyam) in the diets of weaned pigs. Tropical Animal Health
231 and Production, 34:241-247
232 Akinyele Isaac O. (2009). Ensuring and nutrition security in rural Nigeria: an assessment of the
233 challenges, information needs, and analytical capacity. International Food Policy
234 Research Institute, Nigeria.
235 Babayemi O.J. and Bankole M.A (2009). Nutrient value and in vitro gas production of African
236 wild cocoyam (*Colocasia esculenta*). African Journal of Food, Agriculture, Nutrition
237 and Development, 9(1):593-607
238 Chhay T.Y., Khieu Borin, T.R. Preston and Mea Sokveasna (2008). Intake, digestibility and
239 nitrogen retention by growing pigs fed ensiled or dried taro (*Colocasia esculenta*) leaves
240 as the protein supplement in basal diets of rice bran/broken rice or rice bran/cassava root
241 meal. Livestock Research for Rural Development, 19(9), <http://www.lrrd.org>
242 Dotsey P. (2009). The use of cocoyam, cassava and wheat flour composite in the production of
243 rock cakes, HND dissertation, Cape Coast Polytechnic, Cape Coast, Ghana, 1:7-40
244 FAO (1990). Roots, tubers, plantain and bananas in human nutrition. Effect of processing on
245 nutritive values. Food and Agriculture Organization of the United Nations, Rome
246 FAO (2002). The state of food insecurity in the world, 2001. Food and Agriculture Organization
247 of the United Nations, Rome
248 FAO (2005). Impact of climate change, pests and diseases on food security and poverty
249 reduction. 31st session of the committee on World Food Security, Food and Agriculture
250 Organization, Rome
251 Food and Agriculture Organization of the United Nations FAOSTAT (2012).
252 <http://faostat3.fao.org/home/index.html#DOWNLOAD>, retrieved on March 22, 2013
253 Geonaga R., and Hepperly P., 1990. Flowering, pollen and seed viability and artificial
254 hybridization of tanniers (*Xanthosoma spp*). J. Agri. Univer. Puerto Rico. 74(3):253-260
255 Hamzat R.A., A.K. Tihamiyu and A.M. Raji (2003). Effect of dietary inclusion of kola pod husk

- 256 (KPH) on growth performance of West African Dwarf (WAD) goats. Proc. 28th Ann.
257 Conf. NASP, Ibadan, 271-273
- 258 Hang D.T. and T.R. Preston (2010). Effect of processing taro leaves on oxalate concentrations as
259 using the ensiled leaves as a protein source in pig diets in Central Vietnam. Livestock
260 Research for Rural Development, 22(68) from
261 <http://www.lrrd.org/lrrd22/4/hang22068.htm>
- 262 Iyayi E.A., Okoruwa V.O., Babayemi O.J., Busari A.A. and O.F. Peters (2003). Livestock
263 production pattern of agro pastoralists in peri-urban centres of Southwest Nigeria.
264 Nigerian Journal of Animal Production, 30(1):87-92
- 265 Jennings D.L. (1987). Starchy crops In: CRC Handbook of Plant Science in Agriculture. Volume
266 2 (Edited by Christie B.R.) CRC Press Inc. Boca Raton, Florida, USA, pp 137-143
- 267 Jirarat T., Sukruedee A., Pasawadee P. (2006). Chemical and physical properties of flour
268 extracted from taro *Colocasia esculenta* (L) Schott grown in different regions of
269 Thailand. Sci. Asia, 32:279-284
- 270 Ndabikunze B.K., Talwana H.A.L., Mongi R.J., Isa-Zacharia A., Serem A.K., Palapala V. and
271 Nandi J.O.M. (2011). Proximate and mineral composition of cocoyam (*Colocasia*
272 *esculenta* L. and *Xanthosoma sagittifolium* L.) grown along the Lake Victoria Basin in
273 Tanzania and Uganda. African Journal of Food Science, 5(4):248-254
- 274 Nnadi F.N., J. Chikaire and C. Ajaero (2010). Impact of climate change on food security and
275 poverty reduction. Animal Production Research Advances, 6(1):20-24
- 276 Ngo Huu Toan and T.R. Preston (2010). Taro as a local feed resource for pigs in small scall
277 household condition. Livestock Research for Rural Development, 22(8).
278 <http://www.lrrd.org>
- 279 Niba L.L. (2003). Processing effects on susceptibility of starch to digestion in some dietary
280 starch sources. Int.J.Food.Sci. Nutr., 54:97-109
- 281 Obioha F.C. (1972). Utilisation of cassava as human feed. A literature review and research
282 recommendation on cassava. A.I.D. csd/2497. Univ. of Georgia, pp 325.
- 283 Ogunlakin G.O., M.O. Oke, G.O. Babarinde and D.G. Olatunbosun (2012). Effect of drying
284 methods on proximate composition and physic-chemical properties of cocoyam flour.
285 American Journal of Food Technology, 7(4):245-250
- 286 Okon B., Ibon L.A., Nsa E.E. and Ubua J.A. (2012). Reproductive and growth traits of parents

- 287 and F1 hatchings of *Achatina achatina* (L.) snails under mixed feeding regime with
- 288 graded levels of swamp taro cocoyam (*Cyrtosperma chamissonis*) and pawpaw leaves
- 289 (*Carica papaya*). Journal of Agricultural Science, 4(11):289-298
- 290 Olajide R., A.O. Akinsoyinu, O.J. Babayemi, A.B. Omojola, A.O. Abu and K.D. Afolabi (2011).
- 291 Effect of processing on energy values, nutrient and anti-nutrient components of wild
- 292 cocoyam (*Colocasia esculenta* (L.) Schott) corm. Pakistan Journal of Nutrition, 10(1):29-
- 293 34
- 294 Ologhobo A.D. and Adejumo I.O. (2011). Effects of differently processed (*Colocasia esculenta*
- 295 [(L.) Schott) on growth performance and carcass characteristics of broiler fiishers.
- 296 International Journal of AgriScience, 1(4):244-248
- 297 Olomola O.O., Babayemi O.J. and Akinsoyinu A.O. (2008). Performance characteristics and
- 298 nitrogen utilization of pregnant West African dwarf goats fed groundnut cake, urea and
- 299 rumen epithelial wastes in cassava flour and citrus pulp-based diets. Tropical and
- 300 Subtropical Agro Ecosysytems, 8(1):61-67
- 301 Onu P.N. and Madubuike F.N. (2006). Effect of raw and cooked wild cocoyam (*Caladium*
- 302 *bicolor*) on the performance of broiler chicks. Agricultura Tropica Et Subtropica,
- 303 39(4):268-271
- 304 Onwume I.C. and Charles W.B. (1994). Cultivation of cocoyam in: Tropical root and tuber
- 305 crops. Production, perspective and future prospect. FAO Plant Production and Protection
- 306 Paper 126, Rome, pp 139-161
- 307 Palapala V., Talwana H., Nandi J.O.M., Sereme A.K., and Ndabikunze B.K. (2005). Evaluation
- 308 of prospects and constraints to sustainable cocoyam (*Colocasia esculenta*) production in
- 309 Lake Victoria Crescent. A project report
- 310 Pheng Buntah, Ogle R.B., Preston T.R. and Khieu Borin (2008). Digestibilty and nitrogen
- 311 balance studies in pigs fed diets with ensiled taro (*Colacasia esculenta*) leaves as
- 312 replacement for fish meal. Livestock Research for Rural Development, 20 (supplements).
- 313 Smith D.L. (1982). Calcium oxalate and carbonate deposits in plant cells, In: The Role of
- 314 Calcium in Biology System. L.J. Aughiloni and A.M. Tuffet-Anghiloni (eds.) CRS Press,
- 315 Boca Raton Flourida, 253-261
- 316 Sukamoto L.A. (2003). Development of early maturing and leaf blight resistant cocoyam

- 317 (*Colocasia esculenta*) (L.) Schott) with improved taste. Proceedings of final research
 318 coordinated meeting organized by the joint FAO/IAEA division of nuclear technique in
 319 food agriculture held in Pretoria, South Africa, pp 19-23
- 320 Tegua A., Telefo P.B. and Fosto R.G. (2007). Growth performance, organ development and
 321 blood parameters of rats fed graded level of steeped and coned taro tubers (*Colocasia*
 322 *esculenta* var *esculenta*) meal. Livestock Research for Rural Development, 19(6).
 323 <http://lrrd.cipav.org.co/lrrd19/6/tegu19076htm>
- 324 Tewe O.O. (1997). Sustainability and Development Paradigms from Nigerian Livestock
 325 Industry. Inaugural lecture, University of Ibadan, Nigeria.
- 326 Udeybir S.C., P.S. Niranjan and Sanjay Kumar (2008). Handbook of General Animal Nutrition.
 327 Global Media Publisher, pp 267-276
- 328

Table 1: selected taro cocoyam 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 cocoyam

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 wild cocoyam; CWCC= cooked wild cocoyam; FWCC= fermented wild cocoyam

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

Ndabikunze *et al.* (2012)

Table 3: chemical characteristics of taro cocoyam 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

329 Source: Ndabikunze *et al.* (2011)

Table 5: chemical composition of differently processed taro cocoyam leaves

Processing	Dry matter (%)	Crude protein (%)	Crude fiber (%)	Ash (%)	Oxalates (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 meal

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)

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