GARICO: A NEW FOOD OR FEED RESOURCE?

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ABSTRACT
A study was undertaken to examine the potentials of Garico, a by-product of Gari production, from cassava as a new food or feed resource. The procedures for the preparation of Garico, the nutrient composition, its utilization, its particle size distribution compared to that of Gari and the comparative prices of Garico, Gari and maize were determined. Structured questionnaires were administered to 15 and 10 Gari producers in Anloga and Kpo Kɔfe in the Ashanti and Volta Regions respectively. Data obtained were analyzed using descriptive statistics as described by the Statistical Package for Social Sciences (SPSS) version 21. The results obtained indicated that Gari production is dominated by women (80%). Some of the respondents (44%) mentioned that Garico is being consumed by humans and domestic animals. The preference of an average consumer was 68% for Gari only, 4% for Garico only and 28% for both Gari and Garico. Most of the respondents (60%) admitted that the shelf life of Garico could be 1-2 years. The cost per kg of Garico was ¢ 2.76 in the Volta Region and ¢ 3.29 in the Ashanti Region. Nutrient compositions of Garico (ME- 2957-3060 kcal/kg; CP- 0.9-1.4% and CF- 1.38-2%) and Gari were similar and there were some critical processing differences. The mean particle size of Garico was 2mm compared to Gari which ranged from 500µm to 1mm. It was concluded that Garico could be used both as a food and feed resource if diets are well-balanced and particular attention is paid to economic considerations.

Keywords: *By-product, cassava, cynophilist, Garico, Gari*

INTRODUCTION

The major constraint in monogastric livestock production in Ghana has been their feeding, specifically the energy and protein components. Conventional feed resources such as maize used as feed for pigs and poultry also constitute the major staple foods for the Ghanaian populace making them expensive. As a result, the quest to find alternatives is being advocated by stakeholders (i.e. scientists, livestock farmers, extension personnel, etc.) in the livestock industry. There has been considerable interest in recent years in the use of agro-industrial by-products (AIBP) as livestock feed ingredients in developing countries. Okai and Boateng (2007) indicated that most AIBPs are not frequently used in animal feed mainly because of limited research data on their chemical composition and nutritive value. The utilization of these by-products can help minimize the cost of feeding livestock and poultry and the degree of competition between humans and farm animals for food and feed ingredients. Again, it will reduce the pollution hazard posed to the environment since some of these by-products are left on-farm and near processing establishments. Non-conventional feed resources (NCFR) which are those feeds that have not been traditionally used in animal feeding and /or are not normally used in commercially produced rations for livestock could partly fill the gap in the feed supply chain, decrease competition for food ingredients between humans and animals, reduce feed cost, and contribute to self-sufficiency in nutrients from locally available feed resources (Sontakke *et al*., 2014).

It has been known for a long time that, cassava and its by-products are good sources of energy for monogastric livestock and potential replacements for maize in their diets (Okai, 1995; Rhule *et al.,* 2012). However, one by-product from cassava processing that has not received much attention is *Garico.* It is a by-product of *Gari* production from cassava (*Manihot esculenta*). The authors are aware that in some parts of the country, *Garico* is readily available and in some cases being used by humans and as a feed ingredient in the local preparation of food for pets particularly dogs. However, there is a dearth of information on its physical and chemical attributes. In view of this, a study was conducted to evaluate *Garico*, as a new food or feed resource. The specific objectives were to determine the demographics of some *Garico* producers, the preparation methods, nutrient composition and utilization of *Garico* and the particle size distribution and cost of *Garico*.

MATERIALS AND METHODS

Description of study areas

The study was conducted in two districts located in two different regions in Ghana, namely, the Volta and Ashanti Regions. *Kpo Kɔʃe*, a suburb of *Mafi-Kumase* in the Central Tongu District in the Volta Region and *Poku Transport* and *Asibi*, both located within *Anloga*, a suburb of the *Oforikrom* Municipality in the Kumasi Metropolitan Assembly, in the Ashanti Region. Data were collected from the three different areas.

Questionnaire administration

A set of structured questionnaires with both closed and open-ended questions were administered to a total of twenty-five (25) *Gari* producers. Fifteen (15) and ten (10) questionnaires were administered to the producers located at *Anloga-Kumasi* and *Kpo Kɔʃe* respectively. There were two main modules in each questionnaire. The first module focused on the demographics of the respondents and the second module focused on information about *Garico* production and marketing. Questions such as knowledge of *Garico*, its preparation and utilization, the prices (per kg) of *Garico* and *Gari*, the form in which *Garico* is consumed, how it is stored and its shelf life were asked.

Sample collection, preparation and proximate analysis

Garico samples were collected from the twenty-five *Gari* producers, ground and their proximate compositions were determined (AOAC, 2000).

Particle size evaluation of *Garico* and *Gari* samples

The particle size distribution of *Garico* samples collected from *Kpo Kɔʃe* and *Anloga*-Kumasi were determined based on the method of Henderson and Perry (1979) for dry flour. A known quantity obtained from *Kpo Kɔʃe* and *Anloga*, as well as *Gari*, were sieved through a set of graded Tyler sieves of aperture sizes 8mm, 2mm, 1mm, 710µm, 500µm, 355µm and 250µm, and manually shaken for 7 minutes. Fractions retained on each sieve were then weighed.

Statistical analysis

Data collected were organized with Microsoft Excel Software. Descriptive statistics were then performed on the data using the Statistical Package for Social Sciences (SPSS) version 22.0 (2013). Data output were presented in tables using frequencies and percentages and pie charts where appropriate.

RESULTS AND DISCUSSION

Demographic characteristics of respondents

Gender, educational background, age, religion and marital status

The majority (80%) of the total respondents interviewed in both regions were females. However, in *Kpo Kɔʃe*, there was an equal number of males and females among the respondents' whiles in *Anloga* only females were involved in the production of *Gari/ Garico* (Table 1). It seems *Gari* production in *Anloga* in the Ashanti Region is totally dominated by females. This is not surprising, because in terms of the type of employment in Ghana, 85.1% of women, are in the private informal sector (Amu, 2005).

Table 1: Gender, Educational background, Age and Religion of respondents

Demographic		*Kpo Kɔfe* (%)*	Anloga/Asibi (%)*	Total (%)*
Gender	Male	5 (50)	0 (0)	5 (20)
	Female	5 (50)	15 (100)	20 (80)
Educational	SHS level	2 (20)	1 (6.7)	3 (12)
background	Primary/JHS level	8 (80)	6 (40)	14 (56)
	No formal education	0 (0)	8 (53.3)	8 (32)
Age (years)	Below 20	2 (20)	2 (13.3)	4 (16)
	21-30	2 (20)	1 (6.7)	3 (12)
	31-40	1 (10)	3 (20)	4 (16)
	41-50	4 (40)	3 (20)	7 (28)
	Above 50	1 (10)	6 (40)	7 (28)
Religion	Christianity	10 (100)	15 (100)	25 (100)
Marital status	Single	4 (40)	4 (26.7)	8 (32)
	Married	5 (50)	7 (46.6)	12 (48)
	Divorced	0 (0)	0 (0)	0 (0)
	Widowed	1 (10)	4 (26.7)	5 (20)

**Figures in parenthesis are percentage values*

Most of the *Gari* producers (68%) had attained primary school education or higher (i.e. JHS and SHS) level and 32.0% had not received any form of formal education (Table 1). This indicates that *Gari* production does not require a high level of education or extensive efforts to learn. However, their low educational status may limit their adoption of new technologies or the marketing/ packaging of their products because education has a direct effect on technology adoption (Aneani *et al.,* 2012). It is worth noting that, the educational levels of females in Ghana are generally low although women constitute about 52% of the Ghanaian population (Ghana Statistical Service, 2012). According to a survey report by the Institute of Economic Affairs (IEA, 2016), a majority of females (61.4%) in Ghana had no formal education.

The ages of the respondents were almost evenly distributed although the age ranges of 41-50 years and above 50 recorded the highest percentages (i.e. 28% each). This implies that most of the youth in these locations are not into *Gari* production.

All the respondents (100%) in the two Regions were Christians (Table 1). No Islamic or Traditionalist was recorded. This could be because the areas where the data was collected was dominated by Christians. For instance, a study conducted to assess the socio-economic and political status of women in Nanumba North District in the Northern part of Ghana indicated that, majority of them (86.4%) were Muslims (Abdul-Fatawu, 2014). This implies that the place or location of studies may have an effect on the religious affiliation of the people living there (Abdul-Fatawu, 2014).

The majority of the respondents (48%) were married, 20% widowed and 32.0% were single. *Anloga*-Kumasi *Gari* producers were the most married as well as most widowed. The Ghana Population and Housing Census conducted in 2010 indicated that 35.6% of females had never been married (Ghana Statistical Service, 2012).

Production information from respondents

Knowledge about Garico

All the respondents admitted they knew or were familiar with *Garico* and a vast majority (92.0%) of them produce it because there is a ready market for it (Table 2). Some of the respondents (20%) provided other names of *Gari*-

co as *Gari* Aba (Ashanti), *Gari* Po and *Gari* Kpobi (Gas'). It was noted that *Garico* is also interchangeably referred to as *Galico* in the Volta Region. This implies that *Garico* is at least known in three regions in the country (i.e. Greater Accra, Ashanti and Volta regions).

Table 2: Knowledge about *Garico*

Knowledge about *Garico*		Freq.	Percentage
Do you know *Garico*	Yes	25	100
	No	0	0
Do you produce *Garico*	Yes	23	92.0
	No	2	8.0
Are there other names for it	Yes	5	20.0
	No	20	80.0
Is *Garico* a main product	Yes	5	20.0
	No	20	80.0
Is *Garico* a by-product	Yes	24	96.0
	No	1	4.0
Is *Garico* a co-product	Yes	9	36.0
	No	16	64.0

Some domestic animal owners, especially cynophilists used *Garico* as the main source of energy in the diets of their animals. *Garico* is also either soaked in water with sugar and roasted groundnut added or it is blended and added to corn flour for the production of the *akple* - meal which is prepared by adding boiling water and cornflour porridge and further adding more of the flour to make it thick. The addition of *Garico* to the mixture makes the *akple* stiff (Deku, personal communication). On the nature of the product, 20.0% and 36.0% of the respondents tagged *Garico* as a main product and co-product respectively (Table 2) and they either produced it by special order (*Kpo Kɔfe Gari* producers), for normal market sale or use it to blend the dough for roasting. Most of the respondents (96.0%) referred to *Garico* as a by-product. According to them, the main or primary target of interest is the production of *Gari*.

Production of Garico

The procedures for *Garico* production differed among the respondents from *Anloga-Kumasi* and *Kpo Kɔfe* (Fig. 1 and 2). The general procedures involved were peeling, washing, grating, bagging, pressing/fermenting, sifting, roasting, sieving and sun-drying and they are similar to the processes of producing *Gari* from cassava illustrated by James *et al.* (2012) and are further described below.

Peeling, washing and grating

Freshly harvested cassava roots without rot or damage were peeled with sharp knives and washed using a local sponge and fresh water to remove stains and dirt. The peeled pieces of cassava were grated into a mash using motorized graters.

Bagging, pressing and fermenting

The ground cassava was loaded into polythene sacks, tied and pressed or compacted using heavy wood logs and pressers, for a maximum of three days (*Kpo Kɔfe*) or two days (*Anloga-Kumasi*) for fermentation to take place. During this process, moisture and some starch were eliminated.

Sifting

After the pressing and fermentation, the dough obtained was sifted using traditionally produced mesh made from palm fronds, to separate and break clumps as well as to obtain uniform particle sizes. It was observed at *Anloga-Kumasi* that, the cassava chunks (i.e. cassava that did not grate properly) were added back to the fine particles after sifting before roasting.

Roasting

It was realized that during the *Garico* preparation, the temperature was above 100˚C (102˚C-109˚C) at the initial stage of roasting and later reduced to as low as 75˚C after the *Garico* had formed to prevent burning. There was intermittent stirring during roasting.

Sieving

As per the usual preparation at *Anloga-Kumasi*, the *Gari* was sieved with a standard size sieve (0.63-1mm) to separate smaller granules from the bigger granules. The bigger granules were sun-dried to obtain *Garico*. In the case of *Kpo Kɔfe*, the *Garico* was sieved to separate the finer particles from the bigger particles. The finer particles were kept as *Gari* and bigger ones kept as *Garico*.

Flowchart of Garico production in Anloga-Kumasi (Figure 1) and Kpo Kɔʃe (Figure 2)

Figure 1

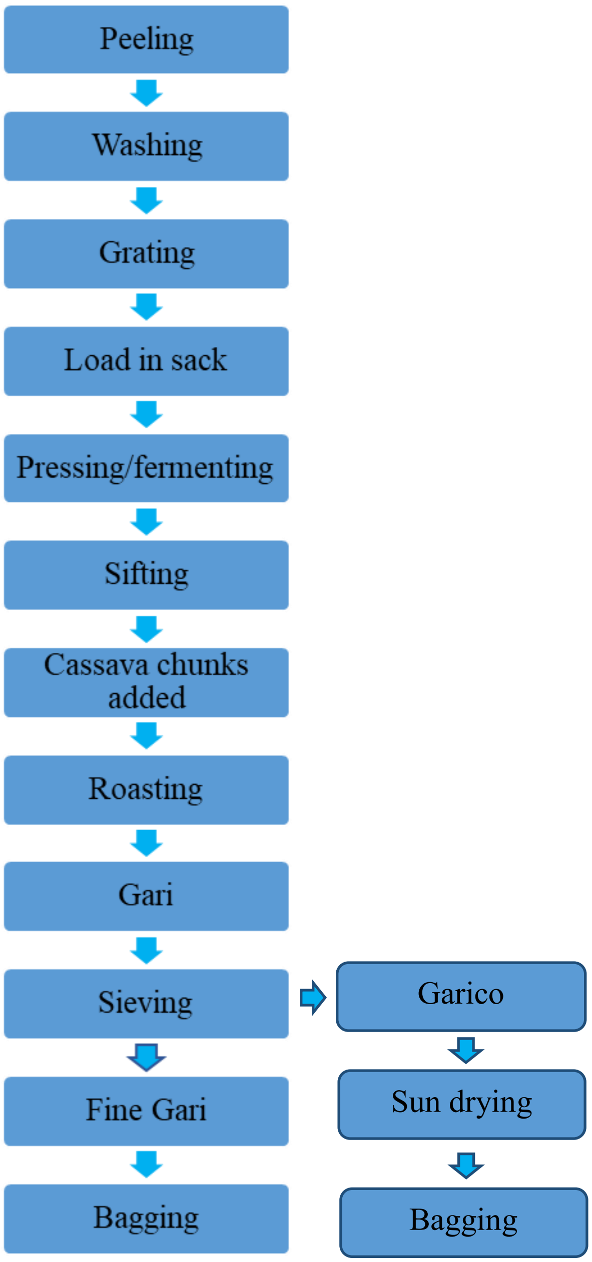
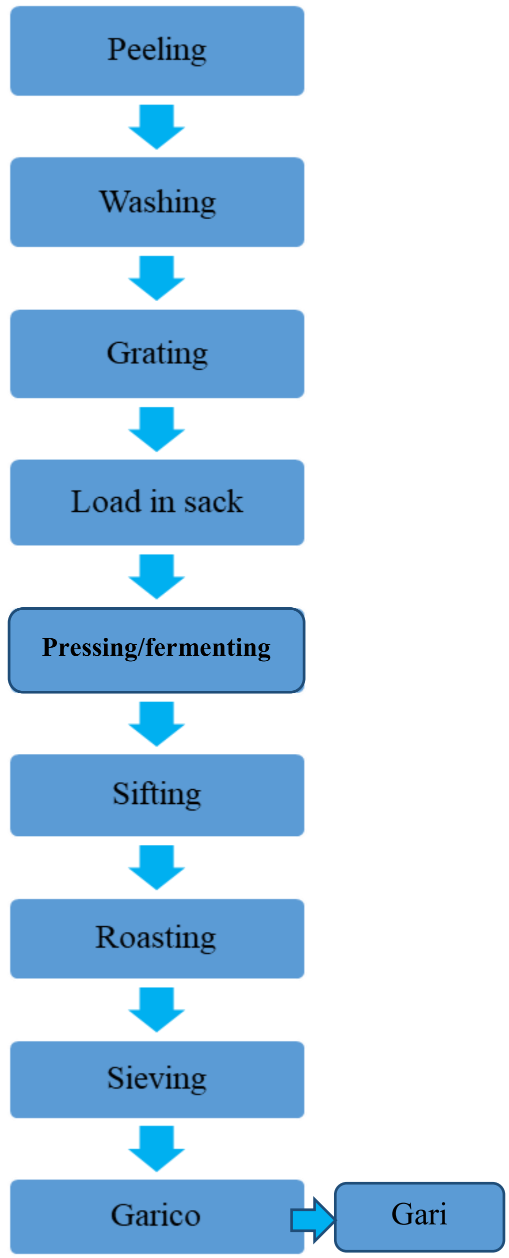


Figure 2



Drying

At *Anloga*-Kumasi, *Garico* after sieving was sun -dried for 1-2 days to become hard for longer storage or shelf-life

Bagging and storage

After drying, the *Garico* was poured into a plastic lining inside a woven polythene sack. The sacks were piled on pallets or raised platform and kept in a cool, dry place. Sixty percent (60%) of the respondents said *Garico* could have a shelf life of 1-2 years (Table 3) if kept away from high humidity, heat, weevils and rodents as indicated in Table 4. This implies that once *Garico* is produced in large quantities, it is available all year round.

Table 3: Shelf life of *Garico*

Life span of *Garico* (year)	Number	Percentage (%)
Below a year	4	16.0
1-2 years	15	60.0
2-3 years	2	8.0
More than 5 years	4	16.0

Causes of Garico spoilage

More than half of the respondents (56%) indicated that moisture could lead to the spoilage of *Garico* (Table 4). Moisture makes *Garico* loose its crispy nature and becomes soggy. The presence of moisture creates a favourable milieu for the growth of fungi or moulds (Pereira *et al.*, 2019). Some of the respondents (24%) suggested that when *Garico* is warm and is put in rubber-lined sacks in an enclosed room, it "produces" moisture, resulting in the spoilage of the stored *Garico*. According to some of the respondents when polythene sacks are not properly sealed, weevils get access to *Garico* and burrow holes into them making it unsaleable. Again, their presence also produces heat through respiration which moistens the *Garico* leading to spoilage. Attack from rodents was the least spoilage factor reported by the respondents.

Table 4: Causes of *Garico* spoilage

Cause of spoilage	Number	Percentage (%)
Moisture	14	56.0
Moisture and weevils	4	16.0
Moisture and rodents	1	4.0
Heat and moisture	6	24.0

Utilization of Garico

Some respondents (44%) acknowledged that *Garico* was being used by both humans and animals as a food or feed source (Table 5). *Garico* just like *Gari* can be either soaked in water with sugar and roasted groundnut added or it is blended and added to corn flour for the production of 'akple' as stated earlier. However, most of the respondents (68%) preferred *Gari* being used as human food to *Garico* (Table 5). This implies that *Garico* can be used as an alternative source of energy in the diet of animals without any major competition from man.

Garico was also used to blend the cassava dough for *Gari* roasting. This was observed among the *Gari* producers at *Anloga-Kumasi*. After the

Table 5: Utilization of *Garico* and preference of the average consumer

Use and preference of *Garico*		Number	Percentage
Use of *Garico*	Human consumption	4	16.0
	Animal feed	9	36.0
	Both human consumption and animal feed	11	44.0
	Blending with dough for roasting	1	4.0
Preference of the average consumer	*Garico*	1	4.0
	Gari	17	68.0
	Both *Gari* and *Garico*	7	28.0

Garico was dried, it was ground into a fine powder and added in bits during sifting to absorb moisture in the dough. The pressing, which was done for a day or two was not able to remove all the moisture content. It was also added to prevent the product from sticking in the pan during roasting.

Cost* (¢/kg) *of Gari, Garico and Maize

In *Kpo Kɔʃe* in the Volta Region, the cost of *Gari* (¢2.00/kg) and *Garico* (¢2.76/kg) were lower than maize (¢3.60/kg). On the contrary, *Gari* and *Garico* were more expensive than maize in *Anloga*-Kumasi (Table 6). It is important to note that, both *Gari* and *Garico* are cheaper in *Kpo Kɔʃe* than at *Anloga*-Kumasi. It can, therefore, be inferred that; one's location must be considered when selecting *Garico* or *Gari* as a food or feed ingredient in the diets of humans or animals.

Table 6: Cost of *Gari, Garico* and Maize (¢/kg)

	(¢/kg)		
District	***Garico***	***Gari***	**Maize**
Kpo Kɔʃe-Mafi Kumase	2.76	2.00	3.60
***Anloga*-Kumasi**	3.29	3.53	2.27

Proximate composition of *Garico*

Garico from *Kpo Kɔʃe* contained higher ($p<0.05$) moisture (Table 7) compared to *Garico* from *Anloga*-Kumasi and this could be due to the processes involved in its production. For instance, *Garico* from *Anloga*-Kumasi after the collection was further sun-dried before bagging as described earlier (Figure 1). This implies that *Garico* from *Anloga*-Kumasi may have a longer shelf life than that from *Kpo Kɔʃe*. Although the CP content of *Garico* obtained from *Anloga*-Kumasi was higher ($p<0.05$) than that from *Kpo Kɔʃe*, the values from the two regions were generally low. This is not surprising because the main product from which they are made i.e. cassava is low in protein and has a poor amino acid profile (Taiwo, 2007). Again, the procedure involved in the production of *Garico* in *Anloga*-Kumasi (Figure 1), that is, the addition of cassava chunks after sifting, could have contributed to its higher crude fibre content ($p<0.05$) when compared to that from *Kpo Kɔʃe.* Crude fat was not present in any of the samples collected but it could have been present if some quantity of palm oil was added to produce yellow *Garico* or *Gari* or if some quantity of vegetable oil was smeared in the pan before roasting started a common procedure in some parts of the country.

Particle size distribution

The particle size distribution of the *Garico* from the two regions were compared to *Gari* using graded Tyler sieves (Table 8). At the final compartment of the graded Tyler sieves (i.e. <250µm), different quantities of particle size of the three samples were obtained with the *Gari* having the highest percentage followed by the *Garico* from *Anloga*-Kumasi and that of *Kpo Kɔʃe* (Table 8). This is because *Gari* is usually finer compared to *Garico*. The *Garico* from *Anloga*-Kumasi had finer particles than *Garico* from *Kpo Kɔʃe* and this may be due to the differ-

Table 7: Proximate composition of *Garico*$^{\Phi}$

Parameter (%)	***Anloga*-Kumasi**	***Kpo Kɔʃe***	**p-value**
Moisture	9.50^{a}	13.25^{b}	0.022
Crude protein	1.44^{a}	0.91^{b}	0.001
Crude fibre	2.00^{a}	1.38^{b}	0.003
Ash	1.16^{a}	0.97^{a}	0.47
Nitrogen-free extract	85.91^{a}	83.50^{a}	0.085
Metabolizable energy(kcal/kg)$^{\#}$	3060.13	2956.77	-

ab- Means on the same row bearing different superscripts are significantly different (P < 0.05).
$^{\Phi}$No values were obtained for Ether extract.
$^{\#}$Metabolizable energy was calculated using Pauzenga (1985) equation
(i.e. ME = 37 x % CP + 81.8 x % EE + 35 x % NFE)

Table 8: Means of the particle size distribution (%)

Samples*	Sample size (g)	< 250 (µm)	250 (µm)	355 (µm)	500 (µm)	710 (µm)	1mm	2mm	8mm	Total (g)	% loss
Gari	123.94	1.84	5.91	13.9	26.18	15.63	24.65	9.96	0	121.54	1.93
Garico (Kpo Kɔfe)	59.7	0.07	0.54	0.94	1.86	0.7	9.46	75.33	8.14	57.93	2.96
Garico (Anloga)	133.21	0.4	0.38	0.37	3.86	0	22.57	66.13	4.78	131.2	1.51

**Means of 3 samples per location i.e. 3 samples from Kpo Kɔfe and 3 samples from Anloga-Kumasi*

ent processes involved which have been described earlier (Figures 1 and 2). In *Anloga*-Kumasi, *Gari* was the main product and *Garico* was obtained through sieving, therefore, allowing the finer particles the chance to mix up with it. On the other hand, in *Kpo Kɔfe, Garico* was the prime target in addition to *Gari* hence efforts were made to produce bigger lumps than fine particles.

The particle size distribution of *Garico* in the <250µm sieve was different compared to that of the *Gari* (Table 8). Most of the *Garico* from *Kpo Kɔfe* (75.33%) and *Anloga*-Kumasi (66.13%) settled in the 2mm sieve compared to *Gari* which was only 9.96%, an indication of larger particle size of *Garico.* According to Oduro *et al*. (1999), the particle size of *Gari* ranged from 0.63- 1.02mm and this conforms with the results of this study with the majority of the *Gari* samples settling in sieve sizes ranging from 0.5-1mm. There were losses of *Gari* (1.93%) and *Garico* from *Kpo Kɔfe* (2.96%) and *Anloga*-Kumasi (1.51%) after sieving with the set of graded Tyler sieves. This may be due to some physical factors like the air, which may have blown some of the very fine particles (particles in the <250µm sieve size) away (Schwarz *et al*., 2002). It may also be due to the manual shaking, with a man as the source of error i.e. inconsistency in the energy used in shaking due to tiredness (Schwarz *et al*., 2002). Generally, *Garico* from *Kpo Kɔfe* and *Anloga*-Kumasi were different in their particle size distribution.

Garico as a possible source of energy and nutrients for humans

As stated by Esiegwu (2017), *Gari* contains 1.40% crude protein, 3.5% crude fibre, 1.19% ash, 9.25% moisture and 3154.60 Kcal/kg. The fermentation processes involved in *Gari* production reduces the HCN to levels tolerable for human consumption (Irtwange and Achimba, 2009). *Garico* is a by-product obtained from *Gari* production and as indicated earlier, its production processes, as well as the nutrient composition are similar to *Gari*. The metabolizable energy content of *Garico* from *Anloga*-Kumasi (3060.13 kcal/kg) and *Kpo Kɔfe* (2956.77 kcal/kg) are similar to the values for *Gari* and therefore it can be considered as an energy source in a diet.

Garico as a source of energy and nutrients in animal feed

Several scientists (Akinfala *et al*., 2002; Salami and Odunsi 2003) have advocated the use of processed cassava root meal as an alternative, but a partial replacement for maize in the diets of livestock animals. Vantsawa (2009) indicated that *Gari* can replace maize in the diets of egg-type chicks (0-8 weeks of age) without any difference (p>0.05) in the feed to gain ratio, cost per kg gain value and health status of the birds. It is fairly common knowledge in Ghana that, some dog owners and breeders used *Gari* or *Garico* as the main source of energy in the diets of their dogs. According to Lallo *et al.* (2016) feeding starter and grower pigs with diets that contain 562 g/kg of dried cassava by-products led to similar (p>0.05) growth performance compared to a corn-based diet. *Garico* is not too different from *Gari* in terms of nutrient composition, therefore, confirming its use as an energy source in the diets of livestock.

Advantages of *Garico*

Cassava is a perennial vegetative shrub therefore available in any season in the tropics. On this basis, *Garico* production can be all year round, unlike maize, which is annual and expensive to produce. Cassava is used as a cheap source of carbohydrate for humans and animals (McDonald *et al*., 1995). Depending on the location (eg. *Kpo Kɔʃe*), *Garico* can be a cheap source of energy for livestock and humans. Apart from being a rich source of energy owing to its high carbohydrate content, *Garico* is also a good source of fibre which is a remedy in fighting constipation and other rectal problems like haemorrhoids, rectal prolapse and proctitis. According to Lindberg (2014), fibre can have prebiotic effects in pigs due to interactions with the gut micro-environment and the gut-associated immune system. This property can be exploited and used as a means to stimulate gut health and thereby minimize the use of anti-microbial growth promoters. In addition, the fibre in the diet will increase satiety, affect behaviour and overall improve animal well-being.

Disadvantages of *Garico*

The cyanide content of cassava and cassava products is a side effect that may arise if the processing is not properly done and its accumulation in the human body normally leads to neurological disorders and goitre (Ojo and Akande, 2013). Based on the protein content of *Garico* (Table 7), the use of *Garico* or *Gari* as an ingredient in the diets of humans or livestock will continue to be viable but the need to ensure the use of a balanced but economical diet for both humans and animals cannot be over-emphasised.

CONCLUSIONS

It can be concluded based on the results of this study that the:

- Difference in the processing of *Gari* and *Garico* is the addition of cassava chunks by the producers in the Ashanti Region.
- Nutrient composition of *Gari* and *Garico* are similar.
- *Garico* can be used as a food and feed resource if diets are well-formulated and economical to feed. In this respect, the location of the production processes is equally important
- Usage of either *Gari* or *Garico* in terms of the cost depends on one's location.
- Mean particle size of *Garico* is 2mm and this is very different from *Gari*, for which the value ranged from 500µm to 1mm

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