NUTRIENT COMPOSITION, AVAILABILITY, CURRENT AND POTENTIAL USES OF *DUSA*: A CEREAL BY-PRODUCT OBTAINED FROM "*KOKO*" (PORRIDGE) PRODUCTION

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ABSTRACT

Samples of Dusa, a cereal by-product derived from "Koko" (porridge) production, from twenty "Koko" producers located at Aboabo, Akwatia Line, Dagomba Line, Adukrom, Roman Hill and Sabon-Zongo, all suburbs of Kumasi in the Ashanti Region of Ghana were analysed to determine nutrient composition, establish the extent of availability, the current and potential uses. Questionnaires were administered at each production site to determine, inter alia, the type of cereals used, production processes, the extraction rate and cost (¢/kg) of dry Dusa. The samples were analysed for their proximate composition and (%) NDF, ADF and Hemicellulose. The mean DM, CP, EE, CF, Ash and NFE ranged between 89.58-93.02, 10.51-21.86, 1.42-5.38, 4.70-10.77, 0.68-4.55 and 58.29-68.89% respectively and the corresponding mean NDF, ADF and Hemicellulose ranged from 27.56-62.47, 6.52-14.95 and 18.76-50.08%. There were significant ($p<0.05$) differences between the products from the different sites with respect to their DM, CP, CF, Ash and NFE contents. The survey showed that mainly backyard farmers patronised Dusa and the data collected indicated that the extraction rate for Dusa was 9.02%. The price of dry Dusa ranged between ¢ 200.00 and ¢300.00/kg. Dusa is comparable to other cereal by-products such as rice bran, maize bran, wheat bran, etc. in nutrient composition and can therefore be used in ration formulation for both ruminant and non-ruminant livestock.

Keywords: *"Koko", "Dusa" Nutrient Composition, Uses,*

INTRODUCTION

The diet of the average Ghanaian is low in animal proteins because of the low-income status and the high prices of most meat and meat products. Ghanaian poultry and livestock producers should therefore aim at supplying consumers with reasonably priced meat and meat products. The generally high cost of feed inputs has not made it possible for this goal to be achieved. This situation is partly the result of competition between man and livestock for some feed and food ingredients, particularly energy sources such as maize (Okai and Aboagye, 1990). The solution to this problem of escalations in prices of animal products may be in the use of alternative feed resources that are not competed for by man and are therefore cheaper. (Okai and Aboagye, 1990).

Agro-industrial by-products have been evaluated in Ghana as potential alternative feed sources for the non-ruminant farm animals (Okai, 1998). Studies have involved wet brewers spent grains (Okai, *et al*, 1985) cocoa pod husk (Okai *et al*,

1984), dried coffee pulp (Okai and Dabo, 1991), mango kernel meal (Okai and Aboagye, 1986), oil palm slurry (Abu *et al*, 1984), among others.

Dusa is a by-product obtained from the production of "Koko" (porridge) from maize and/or millet. "Koko", a common breakfast meal in Ghana is made from partially fermented cereal flour, with or without spices (like ginger, pepper, etc.). *Dusa,* the solid mass left after sieving/ straining the dough or flour in water can serve as good feed resource for feeding family-owned domestic animals. Preliminary studies by the authors showed that in most cases, *Dusa* is not used but rather thrown away or left to spoil. This may be due to the fact that there is dearth of information on its nutrient composition and production levels.

The objectives of this study therefore were to find out the extent of availability of *Dusa* in the Kumasi area, determine the nutrient composition of *Dusa* from various production processes and provide information on the current uses of *Dusa.*

MATERIALS AND METHODS

Dusa Collection and Handling

Samples of *Dusa*, each of about 1.0kg weight were collected from twenty (20) different *"koko"* producers located at Aboabo, Akwatia Line, Dagomba Line, Roman Hill, Adukrom and Sabon-Zongo, all suburbs of Kumasi. A questionnaire was prepared and administered to determine the type(s) of cereal used, the production processes, the extraction rate and cost (per kg) of dry *Dusa*. The samples were dried in a tunnel solar dryer at a temperature of 50°C for three days. The dried samples were milled in a blender, packed in airtight polythene bags and stored at room temperature.

Chemical Analyses

The dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF) and ash contents were determined according to the procedures of the Association of Official Analytical Chemists (AOAC, 1990). Nitrogen- free- extract (NFE) levels were obtained by difference. The acid detergent (ADF), and neutral detergent (NDF) fibre contents of the samples were determined according to the procedures of Goering and Van Soest (1970). The hemicellulose levels were obtained as the difference between NDF and ADF.

Extraction Rate

The Extraction Rate (ER) of *Dusa* was estimated as:

Statistical Analyses

$$ER = \frac{\text{Quantity of dry residue (Dusa) obtained from "Koko" production (kg)}}{\text{Quantity of cereal grains used for Koko production (kg)}} \times 100$$

The SPSS (1997) Inc. Version 8.0 was used to statistically analyse the data at the 0.05 (5%) significance level.

RESULTS AND DISCUSSION

Survey Data

The distribution of the 20 *koko* producers in the suburbs of Kumasi is shown in Table I. Two (10%) producers were located at Roman Hill while four (20%) were from Akwatia line. The percentage of producers from Dagomba line was 20% while six (30%) were from Aboabo; with 15% (i.e. 3 producers) coming from Sabon-Zongo. There was only one (5%) producer from Adukrom. The ages of the producers/sellers ranged from 16 to 65 with a mean of 37 years (Table I).

It was observed that 75% of the producers used millet, 10% used maize and 15% used maize-millet ratios of 1:2, 1:3 or 2:1 for "Koko" production (Table I). All producers obtained these cereals from the open market. Initially seventy-five percent of the producers used between 1-10kg of cereals daily while 20% were using 11-20kg of cereals/day and only5% used more than

Table 1 Survey Data-Summary

Item Number	Item	Number of Respondents (20)[1]	Percentage
1	Location of Producer/Seller	Roman Hill [2]	10
		Akwatia Line [4]	20
		Adukrom [1]	5
		Aboabo [6]	30
		Sabon-Zongo [3]	15
		Dagomba Line [4]	20
2	Age of Producer/Seller	16-30 yrs [8]	40
		31-50 yrs [8]	40
		> 50 yrs [4]	20
3	Sex of Producer/Seller	Male [-]	
		Female [20]	100
	Number of Dependents	None [3]	15
		1-4 [8]	40
		5 [8]	40
		> 5 [1]	5
4	Level of Education	Never [9]	45
		Islamic (Makalanta) [8]	40
		Primary [2]	10
		J.S.S. [1]	5
5	Status of Production	Producer [1]	5
		Seller [2]	10
		Both [17]	85
6	Years in Production	1-5 yrs [10]	50
		6-10 yrs [3]	15
		11-15 yrs [2]	10
		16-20 yrs [3]	15
		> 20 yrs [2]	10
7	Type of Cereal used	Maize [2]	10
		Millet [15]	75
		Maize and Millet [3]	15
8	Source of cereal	Open market [20]	100
		Own farm [-]	-
9	Initial Quantity of cereal used (kg/day)	1-10 kg [15]	75
		11-20 kg [4]	20
		> 20 kg [1]	5
10	Current Quantity of cereal used (kg/day)	1-10 kg [12]	60
		11-20 kg [6]	30
		21- 30 kg [1]	5
		31-40 kg [1]	5
11	Form in which cereal is milled	Soaked [20]	100
		Dry [-]	
12	Soaking Period	24 hrs [12]	60
		24-48 hrs [8]	40
13	Flour / Dough sieving	Yes [20]	100
		No [-]	
14	Straining Material	Calico [6]	30
		Mosquito net [13]	65
		Head Scarf [1]	5

Item Number	Item	Number of Respondents (20)[1]	Percentage
15	Use of *Dusa*	Fed to Animals [7]	35
		Thrown away [5]	25
		Sold [7]	35
		Given away [1]	5
16	Animals fed to	Sheep [4]	57.1
		Sheep and Goats [1]	14.3
		Sheep and Cattle [1]	14.3
		Sheep and poultry [1]	14.3
17	Form fed to Animals	Dry [4]	57.1
		Wet [3]	42.9
18	Why thrown away	Of no known use [3]	60
		Difficult to dry [2]	40
19	Form in which *Dusa* is sold	Dry [6]	85.7
		Wet [1]	14.3
20	Price of dry *Dusa*	¢ 200 [7]	100

[1]***Figures in parenthesis represent number of respondents for a particular category***

Table 2: Proximate Composition of *Dusa* from Twenty Producers. (%, air- dry)

SAMPLE	DUSA-TYPE	DM	CP	EE	ASH	CF	NFE
1	Millet	91.98^{bc}	13.92^{d}	2.11^{d}	1.26^{f}	6.66^{f}	68.04^{ab}
2	"	90.15^{de}	12.89^{e}	2.48^{d}	1.50^{ef}	10.78^{a}	62.53^{e}
3	"	90.45^{d}	12.84^{ef}	2.50^{d}	1.87^{de}	8.69^{c}	64.54^{d}
4	"	92.38^{a}	15.02^{c}	3.74^{bc}	1.89^{de}	9.31^{b}	62.42^{e}
5	Maize	90.31^{d}	11.55^{g}	3.24^{c}	0.98^{g}	8.82^{c}	65.71^{c}
6	Maize	91.24^{c}	14.31^{d}	4.19^{b}	0.69^{h}	7.69^{e}	64.36^{d}
7	Millet	93.02^{a}	12.66^{ef}	4.17^{b}	2.59^{c}	6.44^{f}	67.17^{b}
8	M+M[1]	90.18^{de}	14.86^{cd}	5.38^{a}	3.72^{b}	7.92^{e}	58.29^{g}
9	M+M	89.91^{de}	14.30^{d}	1.42^{e}	0.85^{gh}	4.70^{h}	68.49^{a}
10	Millet	91.45^{c}	13.94^{d}	1.98^{de}	3.95^{b}	5.50^{g}	66.08^{bc}
11	"	89.96^{de}	11.22^{g}	4.15^{b}	1.68^{e}	7.69^{e}	64.97^{cd}
12	"	89.82^{de}	13.02^{e}	1.43^{e}	1.62^{ef}	9.19^{bc}	64.56^{d}
13	"	89.58^{e}	14.68^{d}	3.72^{bc}	1.45^{ef}	8.93^{c}	60.80^{f}
14	"	89.59^{e}	17.11^{b}	3.31^{c}	1.38^{f}	7.69^{e}	60.11^{f}
15	"	90.98^{cd}	10.51^{h}	2.01^{de}	1.64^{ef}	7.92^{e}	68.89^{a}
16	"	89.97^{de}	12.27^{f}	3.85^{bc}	2.34^{c}	5.81^{g}	65.69^{c}
17	"	91.20^{c}	13.06^{e}	3.91^{bc}	2.39^{c}	6.36^{f}	65.49^{cd}
18	"	90.85^{cd}	21.86^{a}	2.64^{d}	2.01^{d}	5.75^{g}	58.59^{g}
19	Millet	90.97^{cd}	13.78^{d}	1.98^{de}	1.66^{e}	9.01^{bc}	64.54^{d}
20	M+M	91.94^{bc}	15.41^{c}	3.96^{bc}	4.56^{a}	8.32^{d}	59.69^{fg}
Mean		90.79	13.96	3.11	2.00	7.66	64.05
Std. Error		0.3000	0.2950	0.3140	0.1320	0.1620	0.5410

a,b,c,d,e,f,g,hValues in the same column with different superscripts are significantly ($p < 0.05$) different.
[1]M+M - refers to the Maize+Millet mixture

Table 3: Van Soest's Fibre Analyses of Dusa from Twenty Producers. (% air-dry)

SAMPLE	*DUSA*-TYPE	ADF	NDF	HEMICELLULOSE
	Millet	9.44^{g}	42.77^{k}	33.33^{gh}
2		14.94^{a}	52.78^{e}	37.83^{e}
3		10.73^{f}	42.86^{k}	32.13^{hi}
4		11.65^{e}	62.48^{a}	50.83^{a}
5	Maize	10.76^{f}	29.52^{p}	18.76^{m}
6	Maize	10.19^{f}	39.58^{l}	29.38^{j}
7	Millet	9.19^{g}	44.69^{j}	35.51^{f}
8	M+M[1]	12.70^{d}	32.49^{o}	19.79^{i}
9	M+M	6.52^{i}	38.43^{m}	31.91^{i}
10	Millet	6.52^{i}	51.29^{f}	44.76^{c}
11		11.51^{ef}	47.03^{h}	35.52^{f}
12		13.22^{cd}	59.12^{b}	45.95^{b}
13		13.36^{c}	54.87^{c}	41.52^{d}
14		10.93^{f}	48.78^{g}	37.83^{e}
15		12.43^{d}	53.86^{d}	41.43^{d}
16		7.51^{i}	27.57^{q}	20.06^{l}
17		8.21^{h}	40.21^{l}	32.00^{i}
18		11.32^{e}	43.85^{j}	34.07^{g}
19	Millet	10.92^{f}	45.39^{i}	32.93^{h}
20	M+M	14.10^{b}	37.63^{n}	23.53^{k}
MEAN		10.81	44.76	33.95
Std. Error	0.287	0.2870	0.3350	0.4340

a,b,c,.... - Values in the same column with different superscripts are significantly ($p<0.05$) different.
[1] M+M: refers to Maize+Millet mixture.

20kg of cereals/day. At the time of the survey, 60% used 1-10kg of cereals per day while 30% and 5% used 11-20kg and 31-40kg of cereals/ day respectively. The net weight of wet *Dusa* obtained per kg of cereal used ranged from 0.13 to 0.62kg with a mean weight of 0.32kg and the dry weight obtained per kg of cereals used ranged from 0.03 to 0.19kg.

The survey showed that 30% of the producers fed the *Dusa* to their ruminants and poultry while 25% (5 producers) threw the *Dusa* away claiming that they had no use for it. Another 35% of producers (7) sold the *Dusa* while the remaining 5% (2 producers) gave the *Dusa* to relatives and friends, who most probably fed this to their livestock. Among those who fed the *Dusa* directly to their animals, 57.1% fed it to only sheep, 14.3% fed it to both sheep and goats while another 14.3% fed it to both sheep and poultry. More than 50% of those who fed the *Dusa* to their animals used the dry form of the product (Table 1). The study showed that a vast majority (85.7%) of those who sold *Dusa*, only sold the dry form and at an average price of ¢ 200/kg.

Table 4: Extraction Rate for *Dusa*

Sample No.	Dusa Type	Quantity of Grains used (kg) (a)	By-Product Obtained (kg) (b)	Extraction Rate (%) b/a x 100
1	Millet	10.8	0.36	3.33
2	"	32.4	3.95	12.20
3	"	16.2	1.88	11.60
4	"	5.4	0.36	6.67
5	Maize	37.5	2.02	5.40
6	Maize	15.0	1.23	8.24
7	Millet	21.6	2.59	11.99
8	M+M[1]	10.6	0.72	6.92
9	M+M	15.4	0.95	6.16
10	Millet	10.8	0.79	7.31
11	"	13.5	2.49	18.40
12	"	8.1	0.59	7.28
13	"	8.1	0.90	11.11
14	"	8.1	0.78	9.63
15	"	13.5	0.90	6.67
16	"	8.1	0.46	5.68
17	"	8.9	1.41	7.46
18	"	13.5	1.09	8.07
19	Millet	8.1	0.51	6.29
20	M+M	10.2	0.87	8.52
Mean		13.51	1.24	9.02

[1] *M+M- refers to Maize+Millet mixture*

NUTRIENT COMPOSITION OF *DUSA*

Dry Matter (DM)

As shown in Table 2, the DM in the dry *Dusa* ranged from 89.58 to 93.02%. The mean value for the millet-type *Dusa* samples was 90.82%. The maize-type *Dusa* had a mean value of 90.78% while the maize+millet *Dusa* had a mean value of 90.35%. Significant differences ($P<0.05$) in DM were observed and this could be attributed to the different soaking periods for the cereals. Other factors that were considered to contribute to the differences in the DM were the pressure exerted at sieving, the age and experience of the producer together with the sieve material. For example *Dusa* obtained from the use of the "mosquito" net as the sieve had higher DM than that from calico.

Crude Protein (CP)

The CP level of the *Dusa* samples was quite variable and ranged from 10.5 to 21.86% (Table 2). The millet-type *Dusa* samples had a mean CP value of 13.93% and ranged between 10.51and 21.86%. On the other hand, the maize-type samples had values of 11.55% and 14.31% with a mean CP value of 12.93%. The mean CP content of the maize + millet type *Dusa* was 14.85% and the values for the 3 samples in this category were 14.30, 14.86 and 15.42%. Sample 18 (a millet- type *Dusa*) was significantly ($p< 0.05$) higher in CP than all the other samples. The very high CP value (21.86%) of the millet-type *Dusa* labelled sample 18, was unexpected but could be attributed to varietal difference in the millet grains. The range of CP values obtained from the millet samples in this study may be considered consistent for the grain (Deyoe and Robinson, 1979; Kent, 1980). The maize-type samples had significantly ($P<0.05$) lower CP than the millet-type due to the differences in protein content of these two cereals. Maize has an average CP of 9.0% compared to 14.4% for millet (Gohl, 1981). The levels of nutrients in the soil particularly nitrogen might influence the level (s) of a particular nutrient in the crop grown on that soil. . Hulse *et al.* (1980) indicated that several workers particularly those working on poor tropical soils had obtained increases in grain yield and grain protein content in pearl, finger and common millets with the addition of fertilizers. They further stated that the protein content of sorghum grains increased from 8.4 to 9.5% as N_2 application levels increased from 0-200kgN/ha. The production processes of soaking and wet milling during *"Koko"* production might also contribute towards difference in CP content of the by-product.

Crude Fibre (CF)

The millet-type *Dusa* samples had an average CF value of 7.72% with range of 4.70 to 10.78%, while the maize-type *Dusa* had a range of 7.69 to 8.82% CF with an average of 8.26%. The mixture (i.e. maize + millet) type *Dusa* had a range of 4.70 to 8.32% with a mean value of 6.98%. There were significant differences ($p<0.05$) between the CF values of the *Dusa* samples. The different levels of spices added to the grains before milling might have contributed to the differences in the CF values. Ginger, which is commonly used as a spice is quite fibrous and could influence the overall CF profile of the end product. These significant differences could also be attributed to the differing fibre levels in the two raw materials used in "koko" production and also to varietal CF differences of any particular cereal. It should however be noted, that the varieties of the cereals used in "koko" production were not determined in this study.

Gohl (1981) reported different CF levels for millet grains of different varieties from different areas. He reported 1.5% for bulrush millet from Ghana, 5.9% CF for finger millet from Zimbabwe and 10.0% CF for foxtail millet from the U.S.A. McDonald *et al.* (1995) reported that some of the hulls in millet were not removed by the normal harvesting methods. This could explain the higher CF (10.78%) level in millet-type *Dusa* (Sample 2). *Dusa* could be used for feeding pigs as they can utilise efficiently diets with 7% CF level (Vleck, 1970).

Ash

The mean ash content in the Dusa samples was 2.00. The millet-type *Dusa* samples had a mean ash value of 1.92, the maize-type *Dusa* samples had a mean ash value of 0.82 and the mixture-type *Dusa* had a mean ash value of 2.71. The maize-type *Dusa* had a significantly ($p<0.05$) lower ash content than the other samples. The levels of minerals in the cereals could depend on such factors as variety, soil condition, temperature, rainfall and fertilizer application (Deyoe and Robinson, 1979).

Ether Extract

The millet-type *Dusa* samples had a mean EE level of 2.93% while the maize-type *Dusa* samples had a mean of 3.72% with the maize+millet type *Dusa* samples having a mean value of 3.4%. The EE values were significantly ($p<0.05$) different. The millet-type *Dusa* samples, 1, 2, 3, 10, 15, 18 and 19 were similar ($p>0.05$) in EE content. Samples 4, 6, 7, 11, 13, 16 and 17, and 20 were also not significantly ($p>0.05$) different. However, Sample 8, which was a mixture-type *Dusa* had significantly ($p<0.05$) higher EE content than the rest of the samples. The differences in the % EE values for the maize + millet samples may be attributable to the different fat contents of the different cereal grains used. The variations in the % EE values for maize or millet only *Dusa* can be due to the type of cereal and its nutrient composition. Gohl (1981) indicated that the EE content for bulrush millet from Ghana and finger millet from Zimbabwe were 5.2 and 3.6 respectively while Southgate (1993) gave a range of 2-7% for most cereals.

Nitrogen Free Extract (NFE)

The millet-type samples had a mean NFE value of 59.94% while that for the maize-type *Dusa* was 64.05%. The mixture-type *Dusa* samples had a mean NFE value of 63.4%. Samples 1and15 (millet-type *Dusa* samples) had significantly ($p<0.05$) higher values than the other samples (Table II). The mean NFE of the *Dusa* studied here was 64.05%. Locally-produced rice bran and maize bran may have as much as 50-80% NFE and rice bran from Philippines and Iraq had 46.1 and 46.3 %NFE respectively while wheat bran from Tanzania had 61.6 %NFE (Gohl, 1981). *Dusa* would therefore be expected to have similar or better feeding value for poultry and livestock.

Detergent Fibre (DF) Analysis

The mean NDF value for *Dusa* was 44.76% (Table 3). While the millet-type *Dusa* samples had a mean value of 47.83%, the maize-type *Dusa* samples had a value of 34.58%. The mixture-type *Dusa* samples, on the other hand, had a vlue of 35.46% and the differences between these means were significant ($P<0.05$). Generally, the millet-type Dusa samples had significantly ($p<0.05$) higher NDF values than the maize and the mixture-type *Dusa* samples. This may as stated earlier, be attributed to the presence of more hulls in the millet-type *Dusa* (McDonald *et al.*, 1995).

The mean ADF value for the *Dusa* samples was 10.81%. There was a wider range of values for the millet-type *Dusa* samples (6.52 to 14.95%) than for the maize-type *Dusa* samples (i.e. 10.76 and 10.19%). The mixture samples had a mean ADF value of 10.31% and the means were significantly ($P<0.05$) different. Generally, the ADF values were higher than the CF values (Tables II and III) because the ADF fraction contains lignin in addition to cellulose (Mertens, 1985).

The mean hemicellulose value of the *Dusa* samples was 33.95%; while the millet-type *Dusa* samples had a mean value of 40.5%, the maize-type *Dusa* samples had a value of 24.1%. The mixture-type *Dusa* samples had a value of 21.7%. This affirms that there can be considerable differences in the nutrient profiles of feed and food ingredients.

THE EXTENT OF AVAILABILITY OF *DUSA*

The mean extraction rate for all the *Dusa* samples was 9.02% (Table 4). The mean rate for the maize-type *Dusa* samples was 6.2%. The maize+millet *Dusa* samples had a mean extraction rate of 7.4%. Interestingly the highest and the lowest rates of 18.40 and 3.33% were obtained from the millet-type *Dusa* samples but generally, the millet-type *Dusa* samples had higher extraction rates than the maize and the mixture-type *Dusa* samples. This may probably be due to the relatively higher levels of hulls in the millet grains.

The annual production of maize and millet is about 1,182,000 metric tonnes (MOFA, 2001). If it is assumed that at least 100,000 metric tonnes of these cereals are used for "koko" production then it means that about 9,020 tonnes of *Dusa* can be produced annually for feeding livestock and poultry. *Dusa* was being sold at ¢200-300/ kg dry weight at the time of study and a 16-25kg bag was priced at approximately ¢5,000, on the other hand, a 25kg bag of wheat bran was being sold at ¢16,000 at the time of the study. This suggests that livestock and poultry producers could reduce the cost of feeding their animals by making more extensive use of *Dusa*.

CONCLUSION

This study has shown that the nutrient composition of *Dusa* could be variable. The millet-type *Dusa* had higher CP than the maize and the mixture-types. Some "koko" producers used *Dusa* partly in feeding their domestic animals. Some backyard poultry/pig farmers do buy or collect *Dusa*. It was estimated that about 9,020 metric tonnes of *Dusa* could be available for feeding livestock and poultry annually.

Dusa could help to further reduce the production cost of meat and meat products thereby making them more affordable. However, the problem of how to dry it quickly and efficiently especially in the very humid areas of Ghana would need to be addressed.

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