AGRO-INDUSTRIAL BY-PRODUCTS AND FARM WASTES FOR POULTRY PRODUCTION IN NIGERIA: CHALLENGES AND OPPORTUNITIES

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ABSTRACT

The poultry industry in Nigeria requires up to ninety per cent of the total commercially produced feeds in Nigeria. Conventionally, maize is the major source of energy in poultry feeds in Nigeria, while soybean, groundnut cake and fish meal are sources of protein. Poultry farmers often use alternative feed ingredients whenever the prices of the conventional feed ingredeints increase beyond realization of profit. Agro-industrial by-products (AIBs) are mostly cereal and oil seed processing by-products but when poorly stored agro-industrial by-products often go mouldy neccesitating the use of toxin binders. The substituability of cassava for maize is almost unity but for the additional processing effort that is required for cassava. Hatchery wastes (eggshell, culled eggs, poorly formed chicks) and slaughter houses (blood, bones, rumen scrapping, and feathers) are of animal origin potentially available for inclusion in feed. The use of animal by-products for componding feeds is however becoming less acceptable. Crop wastes that have potential for use in poultry feeding are cassava leaves and also leaves from other crops. The leaves can be good sources of leaf protein when harnessed. Exogenous enzymes results in cost reduction and improved animal performance. Whereas several of these by-products are available for inclusion in poultry feeds either as energy or protein alternatives, wide variation in their nutritional compositions and lower quality compared to the conventional feedstuffs create a situation of challenege in their use. Nevertheless, their potential can be harnessed by guided inclusion levels, further processing, supplementation with exogenous enzymes or a combination of all three factors. In conclusion, to complementing the use of alternatives feed ingredients, the poultry farmer should also be encouraged to increase the efficiency of production by considering proper manipulation of feed, application of appropriate housing system, the use of feed additives among others.

Keywords: By-products, poultry, challenges, opportunities.

INTRODUCTION

The Nigerian poultry industry is faced with challenges, which include difficulty in sourcing necessary inputs such as day old chicks, poor quality feed ingredients, inadequate access to and high cost of veternary services, poor marketing information system, difficulty in capitalization, communual conflict and absence of basic infrastructural development (Adeyemo *et al.*, 2012). In addition, provision of proper housing of chicks in terms of adequate ventilation is often overlooked by the farmer. Poultry production has recorded a growing trend (Table 1) despite these challenges. A USAID sponsored project conducted by Tewe *et al.* (2004) ranked the constraints of the poultry industry in Nigeria (Table 2). At that time, finance ranked first while high cost of feed ingredients ranked third. Recently, prices of feed ingredients have jumped so much that poultry producers in Nigeria are focusing on alternatives to maize, soyabean and other possible ingredients to meet reduced cost of production (Table 3).

Table 1: Estimated National output of livestock products ('000 tonnes)

Item	2001	2002	2003	2004	2005
Poultry meat	81.1	82.3	83.1	91.4	110.9
Goat meat	421.8	442.1	490.6	511.6	524.4
Mutton	400.6	419.9	472.5	486.5	498.1
Beef	177.0	185.6	232.5	239.8	235.1
Pork	53.5	56.1	58.5	62.3	66.5

Source: CBN (2005)

Table 2: Constraints of the poultry industry in Nigeria

Production constraints	Rank order
Finance	1
Seasonal and periodic egg gluts	2
Lack of infrastructure (Water, Road and Electricity)	2
Vaccine / Drug potency and disease diagnosis	3
High cost of feed ingredients	3
Quality of feed ingredients	4
Quality of DOC and hatchery problems	5
High cost and non-availability of day-old-chicks (DOC)	5

Source: Tewe *et al.* (2004)

Table 3 Unit Prices (Naira) of some Poultry Input and Output (₦) (1982 – 2007)

	1982	1985	1988	1997	2004	2007	2013
Maize/tonne	270	650	1,800	22,000	30000	50,000	65,000
Concentrate/tonnne	520	760	2320	30000	40000	78,000	135,000
Feed/25kg	8.0	16.50	38.00	500	850	1,680	2,650
Eggs/tray	3.0	6.50	11.50	180	350	500	700
Poultry meat/kg	3.30	7.50	13.00	250	350	450	750
Culled layers/unit	6.00	13.00	18.00	300	450	600	800

Source: Updated from Tewe (1997)

Commercial feed production in Nigeria

The poultry industry requires up to 90% of the total commercially produced feeds in Nigeria (Table 4). The industry is therefore adversely affected in situations of high prices of feed ingredients or their unavailability. Conventionally, maize is the major source of energy in poultry feeds in Nigeria while soybean, groundnut cake and fish meal are sources of proteins. At presently, the cost of maize has risen astronomically that the Nigerian poultry farmer is searching for alternatives to maize. Apart from maize, the prices of other poultry inputs have also skyrocketed (Table 4). The rise in poultry population means there will be a futuristic high demand for feed ingredients for poultry production.

Table 4: Annual Feed Requirement for Commercial Livestock and Fish in Nigeria

Species	Quantity (Metric tonnes)		%
	1992[1]	2004 Projections[2]	
Poultry	448,276	762,069	91.00
Pigs	14,942	22,852	3.00
Cattle/Sheep/Goats	9,962	23,640	3.00
Rabbit	4,981	7,617	1.00
Fish (Aquaculture)	19,924	19,924	2.00
Total	**498,085**	**836,102**	**100.00**

[1]RIM (1992)
[2]Adapted from Draft Livestock Perspective Plan 2005), Federal Dept. of Livestock and Pest Control Services, Abuja

It is the objective of this paper to discuss the poultry feed industry in Nigeria with respect to the following;

Inventory of agro-industrial by-products and problems of usage

Characteristics of some agro-industrial by-products

Limitations and potentials for use of some agro-industrial by-products in poultry rations

Role of exogenous enzymes in use of agro-industrial by-products

Way forward for enhanced utilization of agro-industrial by-products

Inventory of poultry feed ingredients in Nigeria

Table 5 shows the various feed ingredients currently used or having potentials for use in the poultry feed industry in Nigeria. The Nigerian commercial poultry farmer uses maize and occasionally guinea corn or mixtures of both as major sources of energy. In recent times the use of cassava chips have been encouraged due to increase in the price of maize. The use of cassava as a source of energy in poultry is worth considering especially against the backdrop of present cassava glut in the cassava market. The use of cassava and its by-products in poultry feed formulations have been extensively studied at the Department of Animal Science, University of Ibadan. Since poultry feed is largely dependent on use of agro-industrial by-products, it is worth exploring the characteristics of these agro-industrial by-products. Tables 6-10 show the inclusion levels of some conventional and alternative ingredients for poultry in Nigeria.

Characteristics of agro-industrial by-products (AIBs) and farm wastes

Agro-industrial by-products have the following characteristics;

a) Most are residues from cereal and oil seed processing e.g. wheat offal, corn offal, palm kernel cake, soybean meal.
b) Inventory of agro-industrial by-products not very reliable.
c) Fibrousness of agro-industrial by-products limits their utilization in poultry.
d) Some of the agro-industrial by-products may need further processing before adoption and use in poultry production.
e) Limited amount of crop farm wastes can serve as feed resource for poultry.
f) Prices tend to rise astronomically as soon a use is found for livestock production.
g) Poorly stored agro-industrial by-products often go mouldy hence need to add toxin binders to feeds compounded with AIBs inclusion.

Table 5: Available feed ingredients in Nigeria

Nutrients	Conventional Ingredients	Alternative ingredients
Energy	Maize	Sorghum, Millets, Whole wheat, molasses, biscuit waste, cassava chips, cassava grits, Koko gari , full-fat soybean etc
Protein	Milk powder, fish meal, meat meal, groundnut cake, soybean cake	Sunflower cake, full-fat soybean, cottonseed cake, coconut meal, blood meal, dried brewer's yeast, hydrolyzed feather meal, sesame meal, cocoa by-products, cassava leaves, hatchery wastes, edible mushroom
Filler materials	Wheat offals	Maize offals, Brewer's dried grains, palm kernel cake, rice bran, rice husk, sorghum offals, corn cob, malt dust, cassava starch pomace, cassava peels, cocoa waste, shea butter cake, yam peels, melon husk,cocoa husk
Minerals Micro ingredients	Bone meal, oyster shell, salt Vitamins, trace minerals, antibiotics, medication feed, additives, methionine, lysine, enzymes	Periwinkle shells, limestone, super phosphate (Mostly essentially imported)

Source: *Adapted from Longe (1986), Bello (1988), Tewe and Abu (2007)*

Table 6: Nutrient contents (on fed basis) of some wheat and rice by-products

	Wheat bran	Wheat offals	Rice bran	Rice husk
DM (%)	91.20	89.00	90.00	90.00
ME (Kcal/kg)	1145	1818	2100	N/A
CP (%)	15.40	17.00	13.20	11.00
EE (%)	3.40	6.00	13.00	12.00
CF (%)	10.00	7.00	11.50	38.00
Ash (%)	6.00	4.00	9.50	11.00
NFE (%)	56.40	55.00	42.80	18.00

Source: Olomu (1995)

Table 7: Oil palm processing-based Agro-industrial by-products

Class of AIB	Features	Comments
Palm kernel Meal	Gritty and fibrous CP ~ 18% Energy varies with efficiency of extraction. Deficient in lysine. methionine. histidine and threonine	Deficient in lysine. methionine. histidine and threonine It is advisable not to use as a sole source of protein Easily rancid Maximum inclusion level for poultry is 15-20 % for layers and broilers but should be supplied with the deficient amino acids Addition of mannanase improves utilization
Dried oil cake (DOC) "Eruku oshodi"	Oil is further extracted from PKM. Almost oil-free	This product is relatively new in the feed industry. It can only be used as a major fibre source Addition of mannanase improves utilization

Adapted from Tewe and Abu (2007)

Table 8: Soyabean-based Agro-industrial by-products

Class of AIB	Features	Comments
Soyabean meal	By-product of extraction of oil from soybean CP ~ 40-49% depending on extraction efficiency and method. Usually the standard for measuring other oil seed proteins Inclusion level up to 20%	Contains heat labile anti nutritional factors
Full fat soyabean	Unextracted soybean CP ~ 40% High energy because presence of high level of oil.	Contains anti-nutritional factors and hence must be well treated before use. Deficient in methionine Expensive

Adapted from Tewe and Abu (2007)

Table 9: Groundnut-based Agro-industrial by-products

Class	Features	Comments
Groundnut cake	By-product of extraction of oil from groundnut. Two forms; hulls or without hulls With hulls (undecorticated) lower in protein but higher in fibre Protein content 38-48%	Mould infested groundnut cake causes aflatoxicosis Deficient in lysine, methionine and threonine. Inclusion level up to 36%

Adapted from Tewe and Abu (2007)

Table 10: Cotton seed-based Agro-industrial by-products

Class	Features	Comments
Cottonseed cake	By-product of extraction of oil from cotton seed after removal of lint High in fibre (10-13%) Protein content (40-45%) depending on method of extraction	Contains several ANFs e.g. phytate, gossypol Presence of cyclopropenoid fatty acids causes pinkish colour of egg albumen Gossypol causes bluish-green discolouration of yolk with severe mottling Limited in methionine, leucine and isoleucine Toll millers claim it loses weight easily and therefore hardly buy and keep in store Addition of FeSO4 improves utilization Avoid in layers' rations

Adapted from Olomu (1995)

Table 11. Conventional and alternative ingredients for poultry production

Nutrient	Conventional ingredient	% inclusion	Alternative ingredients	Maximum inclusion rate(%)
Energy	Maize	55	Sorghum	55
			Cassava	45
			Sweet potato	15
Fibre	Brewers dried grains	15		
	Rice bran	15	Maize offal	10
			Wheat offal	2.5
			Sorghum offal	10
			Rice offal	5
			Cassava peels	10
Protein	Groundnut cake	15	Palm kernel cake	15
	Soya bean meal	15	Cotton seed cake	10
	Fish meal	3	Jack bean meal	10
			Poultry offal meal	10
			Blood meal	5
Minerals	Oyster shell	7.5	Periwinke shell	7.5
	Blood meal	2.5	Limestone	5
			Malt dust	2

Source: Tewe (1997)

Farm wastes

Farm wastes are of animal or plant origins. Hatchery wastes (eggshell, culled eggs, poorly formed chicks) and slaughter houses wastes (blood, bones, rumen scrapping, and feathers) are of animal origin. Unlike animal wastes which are prominent in feed manufacture, crop farm wastes however are of limited uses in poultry feeding. Crop farm wastes that have potential for use in poultry feeding are cassava leaves and also leaves from other crops. The leaves can be good sources of leaf protein when harnessed, but the technique for extraction of leaf proteins is not yet available to feed manufacturing industries in Nigeria.

By-products from cassava that can find possible use in poultry feeding

The leaf meal of cassava can be a good source of protein but it has a limitation of high fibre content. Cassava pellet is produced from peeled cassava while cassava grit is produced from whole unpeeled cassava. Other minor by-products obtained from cassava processing include gari and fufu sieviates. Gari sieviate is produced in little quantity and also competed for as human food hence may not find a place in poultry feeds.

Use of exogenous enzymes in animal feeds

Due to increasing feed costs, inclusion of appropriate exogenous enzymes can improve the utilization of nutrients from poultry feeds. Enzymes can be effective in cost reduction leading to improved feed conversion ratio (FCR). Carbohydrase enzymes for example breakdown anti-nutritive factors such as the non-starch polysaccharides and also increase the availability of starches, protein, minerals. Exogenous enzymes complement the action of the endogenous ones. Table 12 shows some of the exogenous enzymes available for poultry and most enzymes in the market today are simply cocktails of xylanases, glucanases or phytases. Currently, most poultry farmers add these enzymes to poultry feeds without considering the NSPs profile of the substrates and also the apparent metabolizable energy of the feed. Generally, enzymes are more efficient with high fibre rations with low apparent metabolizable energy. Blind addition of enzymes in poultry feeds may therefore be counterproductive

Table 12. Exogenous enzyme suitable for poultry

Enzyme	Substrate	Function	Benefits
β-glucanase	Barley, oats	Viscosity reduction	Enhanced digestion and utilization of nutrients
Xylanase	Wheat, rice	Viscosity reduction	Enhanced digestion and utilization of nutrients
β-galactosidases	Grain legumes	Viscosity reduction	Enhanced digestion and utilization of nutrients
Phytases	Plant feedstuffs	Release of phosphate from phytate-P	Enhanced phosphate absorption
Proteases	Proteins	Hydrolysis of protein	Increased digestion of proteins
Amylases	Starch	Hydrolysis of starch	Supplemental amylase
Mannanase	Palm kernel cake, soyabean meal	Hydrolysis of mannan	Increase glucose

Adpated from Marquardt (1996)

Table 13: Composition of acceptable cassava grit

Moisture Content	8% maximum
Hydrocyanic acid	25 ppm maximum
Starch content	69% minimum
Crude protein	2.5% maximum
Crude fibre	2.6% maximum
Contaminants	Free of sand. animal dung etc
Granule dimension	0.5 – 2.0 mm diameter
Bacterial count	1.0×10^3 maximum
Fungal count	1.0×10^3 maximum
Storability	> 12 months

Source: Tewe (2005)

Cassava chip is not a by-product of cassava processing. The present glut of cassava and the attendant reduced price per tonne may make cassava chips to be considered as a viable alternative to maize (Table 14).

Table 14: Substitutability of Maize and Cassava chips as substitutes in Poultry rations

Properties	Maize	Cassava chips	Comments
Price/Kg (N)	50	25	Price of cassava nearly always lower than that of maize.To substitute cassava for maize, price of cassava should not exceed 60% the price of maize
Energy (ME/kg)	3.4	3.1	Almost equal calorific density
Crude protein (%)	9.0-10.0	2.5-3.0	Maize almost three times in protein content
Crude fibre (%)	2.2	2.24	Almost equal
Ether extract	5.3	0.54	High ether extract is responsible for the high energy value of maize
Anti nutritional factor	Phytate	Glucosides (HCN)	Need for enzyme addition and further processing
Manufacturing dust loss (%)	0.3-0.5	10-12	Add oil to reduce level of dust in cassava, pelleting
Degree of price fluctuation	Fairly stable	Stable	Cassava is readily available
Inclusion level	70%	20%	Cassava lower inclusion levels
Xanthophyll	Present (yellow maize)	Absent	Xanthophyll is the pigment responsible for yellow colour to the skin, shank and beaks of broilers and gives an orange-red colour to the egg yolk.

Table 15: Performance characteristics and Economic Analysis of Broiler Chickens fed graded levels of energy

Parameters	Com I (HE*)	Exp Control (HE)	Exp Control (LE**)	5 % Cassava peels	5 % Cassava starch residues
Total feed intake (Kg)	3.62	3.84	4.01	4.05	4.07
Final live wt (Kg)	2.28	1.89	1.81	1.79	1.86
Mortality (%)	5	5	0	0	0
Cost feed Intake (₦)	217.21	182.52	203.07	205.26	109.94
Cost/kg meat (₦)	95.26	96.57	112.19	114.67	109.94
CP (%)		20.13	22.80	2261	22.01
ME Kcal/Kg		3249.0	3000.0	3003.0	3004.4

*HE, High energy; **LE = Low energy

Tables 15-17 show performance of broilers when maize is replaced with corn offal and cassava peels respectively with or without enzyme cocktail. Both reports show that maize can be reduced by about 50% with a reduction in cost of feed and uncompromised performance.

Table 16: Growth and Economics of Production of Finisher Broilers Fed High Fibre Diets Supplemented With Avizyme 1500.®

Parameters	T1 No Enzyme (-ve control)	T2* No Enzyme (high fibre)	T3* + 1g/kg Enzyme (high fibre)
Average initial body weight (g)	700.0	755.0	730.0
Average feed intake (g)	112.5	111.1	116.1
Final body weight (g)	1963.7[a]	1917.6[b]	1946.4[a]
Total weight gain (g)	1263.9	1162.6	1215.2
Average daily weight gain (g)	45.1[a]	41.5b	43.4[a]
Feed conversion ratio	2.44[c]	2.86[a]	2.69[b]
Feed cost/kg (₦)	25.2	22.3	22.8
Total feed cost (₦)	79.2	69.2	74.0
Cost/kg eviscerated weight (₦)	16.3	19.5	17.6
Feed cost/kg gain (₦)	62. 9	59.7	60.6
Vent pasting (% birds affected)	16. 7	33.3	3.33

Source: Abu et al. (2005)

*High fibre: In Diets T2 and T3, 50% of maize was replaced with corn offal.

Figures bearing the different superscript along a row are significantly different ($P < 0.05$)

Table 17: Performance and cost of production of finisher broiler fed Roxazyme G based Diets

Parameters	Diets*					SE
	0 % CPM	50% CPM- E	50% CPM+E	100% CPM-E	100% CPM+ E	
Weekly feed intake (g)	0.97^{a}	0.82^{b}	0.88^{a}	0.65^{c}	0.67^{c}	0.04
Efficiency of feed utilization	4.41^{a}	4.55^{b}	4.42^{a}	9.28^{d}	5.15^{c}	0.74
Weekly wt gain (kg)	0.22^{a}	0.18^{b}	0.22^{a}	0.07^{d}	0.13^{c}	0.02
Feed conversion ratio	0.23^{a}	0.21^{a}	0.18^{b}	0.10^{c}	0.17^{b}	0.02
Cost of feed intake (₦)	20.0	15.8	17.0	11. 6	11.9	

Source: Iyayi and Yahaya (1998)

*CPM = cassava peel meal. CPM-E = cassava peel meal without enzyme and CPM + E = cassava peel meal with enzyme.
Values without same superscript are significantly different ($P < 0.05$).

Conclusion, challenges and recommendations

This paper reviewed the usefulness of some agro-industiral by-products for poultry production in Nigeria. Whereas several of these by-products are available for inclusion in poultry feeds either as energy or protein alternatives, wide variation in their nutritional compositions and lower quality compared to the conventional feedstuffs create a situation of challenege in their use. Nevertheless, their potential can be harnessed by guided inclusion levels, further processing, supplementation with exogenous enzymes or a combination of all three factors. The paper concludes therefore;

1. There is general lack of quality control in livestock feed compared to those that exist for human foods.
2. There is the need to pull resources together in research into these agro-industrial by-products and wastes e.g. dearth of knowledge in non starch polysaccharides of our various agro-industrial by-products, giving grants, scholarships, sponsorships for research.
3. Some promising agro-industrial by-products that are not being harnessed in commercial quantities e.g. cassava peelings and starch residues from cassava processing industry. As at now these wastes constitute wastes environmental pollutants.
4. To meet specific feed formulations, there is need to also look at the environment particularly adequate housing design and facilities to maximize profit.
5. The key role of enzymes should be matched with adequate facilities for assessing potency and appropriateness rather than a blind addition as being used at present in most instances.
6. There is need for a comprehensive policy on waste management including its disposal and utilization to create wealth

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