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Conversion of Cassava Peel Waste into High Quality Livestock Feed Ingredient in College, of Education Katsina-Ala, Benue State Nigeria

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Abstract*—This research study has clearly identifies cassava peel waste as an important feed ingredient, assess the impact of the conversion on the environment and examines the growth rate of the different species of animal fed with the cassava peel waste as a major ingredient in their feed. Using a Quasi experimental pre and post data conversion design three objectives three research questions and three hypothesis were formulated for the study. Data were collected from farm records and observation. A significant high level of growth rate was recorded in all the ruminants fed with the cassava peel waste. It also show less or no significant difference in the growth rate among the different sexes of the animal, but a significance difference on the environment was recorded as a result of the conversion of the peel waste into a high valued feed ingredient. This may be attributed the effective conversion which reduce the cassava peed waste from been scattered all over the college environment as a result of food processing. The study also found out that the conversion of cassava peel waste into high valued feed ingredient help in improving educational out come. The study therefore recommended among others the establishment of cassava peel waste conversion facility in all the higher institutions and strategic places in Benue State and Nigeria at large.*

***Keywords*—** *Feed ingredient, Cassava peel, Waste, Educational outcome, Environmental sustainability*.

I. INTRODUCTION

Cereal grains (maize, sorghum, millet and wheat) constitute the bulk of livestock feeds in Nigeria. However, the demands for these grains are very high as they constitute staple food for humans and raw materials in most food processing industries. Consequently, there is a serious competition between humans and animals for these products which makes it very expensive when available. For instance, the price of 50kg bag of maize is ₦60,000.00 in Katsina-Ala market, ₦70,000.00 in Makurdi the state capital and ₦65,000.00 in Wukari Taraba State. The continuous increase in the cost of conventional energy ingredients has necessitated intensive research into more cheaper alternative source of energy yielding unconventional feed resourse ingredients (Amata 2014; Olaiya and Makinde, 2015). One of such alternative comes from cassava peels. Cassava peel is the outer cover of the tuber roots which is usually removed and discarded and allowed to rot away, since it is regarded as a waste. The amount of cassava cultivated and processed into various food materials in Nigeria and particularly Benue State and its environs implies that more cassava peels will be produced within and around Katsina-Ala. Which is at the centre of the state and has a very fertile and conducive environment for cassava production, Cassava peels are waste generated as a result of mechanical removal of the two outer covering of cassava roots prior to its subsequent processing to other cassava product like starch, flour, chips etc.

Cassava *(Manihot esculenta)* is a major subsistence and commercial crop grown in sub-Saharan Africa particularly Nigeria. The crop is consumed by households and livestock. In Nigeria, over 49 million tons of cassava are produced annually which result in about 10 million tons of waste (Okike, Samireadipalla; Kaptige; Faugnet; Atehrkeny; Bandypathyayi; Kulakow; Duncan; Alabi & Blummel, 2015). These unutilized leftover cassava peels represent both wasted opportunity and pose environmental risk. Current disposal method pollutes the air, soil and ground water and creates sanitation problems in the processing environment. As Nigerians population increases, the demand for cassava products is increasing. Processing of cassava roots into food and starch products leaves behind large amount of peels and create environmental hazard in many communities including College of Education Katsina-Ala and its environs because of uncontrolled dumping and burning. Yet there is high cost or shortage of livestock feeds to feed the college of education Katsina-Ala farm animal. The use of cassava peels to feed livestock is an age long practice. The traditional sun drying method use by farmers takes about seven to ten days in dry season but much longer time during the wet season. Improperly dried cassava peels can become toxic through the mycotoxin, aflax aflatoxin and cynanide produced by fungi, which can lead to serious health consequences on the animal and people who consume this animal product. This unreliable method has limited the use of cassava peels as a livestock feed leading to large amount of peels disposed and transformed to smelling toxic effluent. (Unigwe; Raji; popoola; Balogun; Adeukule and Nwokwu 2017).

The conversion of cassava peels waste into high quality livestock feed ingredient allowed cassava peels to be processed more quickly, efficiently and in a greater quantities, the peels cake developed are safer for livestock consumption and have a sheaf life of six months and can also be pulverized further to improve the sieving and drying. The final product can be stored for more than one year at a moisture content of 10 – 12%. (Belt, 2014).

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The conversion of cassava peels helped meet the growing demand of livestock feed while bringing many benefits to the College and many communities, providing jobs and improving the environment. The conversion of cassava peels into high quality feeds reduces the amount of lactic acid-laden effluent piles of peels that contaminates nearby streams, wells and underground water. The conversion process reduced emission of methane gas from the million tons of fermented peels. Waste water from the conversion process was reprocessed as renewable and clean source of energy via biogas production which reduced the amount of firewood uses and contributed to efforts to fight deforestation. The impact on pasture land from livestock grazing also be lessened, thereby benefiting the environment (Unigwe, etal 2017).

Cassava peel mesh conversion provided a low cost, efficient and an excellent alternative feed to maize which is very costly. The conversion of cassava peels into high quality livestock feed ingredient helped to release million of tons of maize meal for human consumption that is otherwise use for animal feed, thus contributing significantly to increased food security.

Purpose of the study

The study was focused on the conversion of cassava peel waste into high quality feed ingredient at college of education Katsina-Ala and to assess the impact of the cassava feed ingredient on growth and productivity of some ruminants like goats, sheep and cattle and also assess the impact of the conversion on the environment.

Objective of the study were to:-

1. Determine the effect of the cassava feed ingredient on growth and productivity among the ruminants goat, sheep and cattle.
2. Describe the impact of the conversion of the cassava peel waste to feed ingredients on environmental sustainability indicators in the college.
3. Describe how the conversion of the cassava peel waste to high quality feed ingredient affect educational outcome of the students in college of education Katsina-Ala.

Research Questions

In line with the specific objectives, this study sought answer to the following research questions.

1. What is the effect of the cassava peel feed ingredient on the growth rate among the three ruminants goat, sheep and cattle?
2. How does the conversion of cassava peel waste to feed ingredient influences environment sustainability in college of education Katsina-Ala?
3. How does the conversion of the cassava peel waste into feed ingredient in college of education Katsina-Ala affect educational outcome of the students?

Hypotheses

In line with the research questions the following null hypothesis were formulated

Ho_1: The conversion of cassava peel waste into high quality feed ingredient has no significant effect on growth and productivity rate of goat sheep and cattle used in the experiment.

Ho_2: The conversion of cassava peel waste into feed ingredient has no significant impact on environmental sustainability in the college.

Ho_3: Educational outcome are not positively affect from the conversion of cassava peel waste into feed ingredient in college of education Katsina-Ala.

II. LITERATURE REVIEW

Theoretical Framework

This study centered on the Theory of Production as a transformation of factor. Input such as crops resources, waste, labour, land livestock and environmental management through the farm firm or producing unit to other goods and services *(*Olayides and Heady, 2006 in Unigwe *et- al., 2023)*. The objective was for profit maximization, output maximization, cost maximization or maximization of satisfaction. The theory of production present the theoretical and empirical framework that facilitates the application of alternative methods so that anyone of combination of the firm's objectives can be attained in production, the relationship between inputs and output could be either of one factor one product, many factor-one product, one factor-two products and many factor-many products, but the focus of this study was on many factors – many products. Cassava peels, waste soil health or environmental health, feed production and conversion, agricultural, environmental conversion and animal growth and productivity.

Conceptual Framework

According to production theory, a farmer is assumed to choose a combination of variable inputs and outputs that maximize profit subjects to technology constraint. The continuous increase in the cost of conventional energy ingredients has necessitated intensive research into the cheaper alternative source of energy yielding unconventional feed resources ingredient (Amata, 2014). One of such alternatives comes from cassava root tuber (Effiong, 2018). Cassava peels is the outer cover of the tuber roots which is usually removed, discarded and allowed to rot away, since it is always regarded as a waste. With pronouncement by the Federal Government of Nigeria that flour millers should make use of not less than 20% of cassava in flour making, it implies that more cassava peels will be produced in most states of the country (Effiong, 2018). It is therefore, imperative to develop technology that will increase the utilization of cassava peels in livestock and also remove it from the environment to avoid environmental hazard ration. Processing of cassava roots into food and starch products leaves behind large amounts of peels that create environmental hazards because of uncontrolled dumping and burning (Choe; Kin etal 2017).

The chemical analysis of cassava peel meal according to Effiong (2018) is 82.55% dry matter 70.67% carbohydrate. Adesehinwa (2019) reported a high crude fibre value of 33.96%, 20.4% and 20.01% respectively.

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Cassava peels can be used as roughage and as energy feed in ruminant diets. However, sun drying ensiling and fermentation should be used to prevent HCN Poisoning when feeding bitter cassava varieties (Unigwe, Okorafor U; Ogbu U; Oladela B; Eimujaze M and Ikokoh 2015). Cassava peel should not be fed alone, as their protein and mineral content cannot support optimum rumen function and productivity. Their optimal utilization requires supplementation with readily fermentable protein (Unigwe; Mhomga; Igwe and Egnu 2023). Cassava peels are found to be highly digestable products.

In Ghana cattle weight gain of 0.29 or 0.33 kg/day were recorded with cross breed grazing bullocks supplemented with dried or ensiled peels (Larsen and Amaning-Kwarrng in Unigwe etal 2023). The high degradability of cassava peels makes it easy to be used as a energy supplement in cattle. Cassava peels can partly replace 30% of total energy concentrates, with no influence on the intake, digestibility, microbial efficiency and nitrogen retention (Azevedo et al 2011).

In Sheep, many trials have been carried out with sheep in sub Saharan African. In Ghana according to Unigwe et al (2023) Djallonke lambs lost weight after consuming a total diet of cassava peels but supplementation with *Ficus exasperate* leaves resulted in weight gains. In Cameron, sheep fed 0.35 or 70% of the diet as cassava peels (and 70,35 and 0% *Pennisetum purpurum.* With cottonseed cake as the protein gained appreciable growth rate. Dry matter intake, digestibility and growth rate increased linearly dietary level of cassava peel (Fomunyan and Mettaja 1987 in Unigwe 2023) sheep may use ensiled cassava peels than sun dried peels. In Nigeria sheep fed a diet containing 80% ensiled cassava peels had greater daily gains than those fed sun dried peels.

Goat in Nigeria a 60:20:20 ensiled mixture of grass legume guinea grass and tropical Kudzu *Pueraria phaseolodies*, cassava peels and poultry excreta fed to West African dwarf goats results in favorable consumption and digestibility, as well as normal rumen and blood metabolites. Olorunniso (2011) recommended the use of cassava peels as energy supplement in anticipation of dry season feeding. In Red Sokoto goats ensiling cassava peels with *pennisetum purpurem* according to Olorunnismo (2011) had beneficial effect on silage properties, intake and digestibility and therefore proposed the use of cassava leaves from at least 30% of silage made from *pennisetum purpureum* to improve productively during dry season. Sun dried cassava peels included up to 74% in supplement ration where they completely replaced maize offal did not affect live weight changes in pregnant Red Sokoto goats grazed on native pasture (Adesehima *etal* 2011, Aro *etal* 2010).

Empirical Studies

Studies have been carried out on cassava as a source of animal feeds indicating that it is a profitable venture. For example Adesehinwa; Fatute; Ajayi; Abiola; Adeleye; Boladoru; Afolabi and Amole (2019) conducted an investigation on High Quality cassava peel mash supplemented with direct fed microbial as an alternate source of energy supplement, effects on performance and blood parameters in growing pig and discovered a positive result. The growth rate of the pig increases. The research is related to the current research because it deals with cassava peels but different with this because that was conducted on pig. This is on cattle, sheep and goats. Unigwe; Mhomga; Igwe and Egwu (2023) conducted a research on cassava peels as feed resource for animal and discovered that feed constitute about 70 – 80% of the total cost of production in any animal enterprise. As a result of the foregoing, non conventional feed staff are being beckoned on for inclusion as substitutes for expensive conventional feed staff like maize. This they found cassava peel having great potential for replacing maize.

Ubalua (2022) conducted a research on cassava waste treatment option and value addition alternative and discovered a lot of option in the use of cassava peel waste.

III. Research Methodology

Research Design

The study employed a Quasi-experimental design with pre and post conversion assessment. Data were collected for one year, six months before the feeding conversion of the animal with cassava peel ingredients and another six months after being fed with cassava peel waste as a major ingredient in their feeds. Dluba and Addulanud (2013) recommended the use of Quasi experimental resign in comparative study.

Population of the Study

The population includes 400 different species of ruminant farm animals 100 cattle, 200 goats and in the department of agricultural education farm 100 sheep. Their ages varied from 6 month-four years.

Farm output record of the various farm animals was also use. The farm management staffs also form part of the population for the study.

Sampling Technique

Purposive sampling was used to select the sample for the study which were farm manager educator, student, all farm records for the pre and post conversion for the 30 selected farm ruminant animal 10 cattle, 10 sheep and 10 goat. This is in line with Abdulhail, (2013) who stated that in experimental and Quasi-experimental research any number of sample can be used.

Instrument for Data collection

Structured questionnaire was use for farm management staff and student. Farm records were analyzed for productivity and weight, gain, financial and environmental condition were equally observed.

Validation of instrument

Content validity was established through expert review of the questionnaire by nutritionist and farm animal expert, Expert in education and environmental specialist. The adequacy and relevant of the question items were judged by experts. The experts were asked to answer the questions and indicate correct options.

Pilot Study

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Pilot testing (study) was conducted with a sub set of the respondents and the private farm was used as the research pilot test to refine the questions in the questionnaire.

Method of Data Collection

Data were collected through structured interview, farm record and direct observation at six month interval for one year.

Method of Data Analysis

Pared t-test were use to compared pre and post test conversion data at 0.05. Descriptive statistics summarized the data.

Demography

TABLE 1: Distribution of the animal base on sex

	Frequency	Percentage	Valid percentage	Percentage
Male	20	66.67	66.67	67.00
Female	10	33.33	33.67	100
Total	**30**	**100.00**	**100.00**	

TABLE 2: Response to feeding of cassava peels as a feed ingredient after a period of four months

	Age (Months)	Weight increase in kg	Percentage
Goat	6-12 Month	35	30.2
Cattle	6-12 Month	52	44.8
Sheep	6-12 Month	29	25.0

On the table 2 the response to growth rate distribution in term of species of the animal used for the experiment and their respective age. Goat showed an increase body weight of 30.2% cattle 44.8% and sheep 25.0%

T-test in order to find the difference between ages of the animal in terms of how they react to the cassava peel waste feed ingredients. The following t-test is presented.

The table 3 above presents the result on the t-test carried on the response to feeding of the animal base on the difference age groups of the different animal feed with the cassava peel waste as ingredient in their feeding, the result (.607) indicate no significance difference in growth between the ages of the animals.

		F	Sig	t	df	Sig 2-tail	Mean Difference	Std Erro difference	95% confidence interval of difference Lower	Upper
Age	Equal Variance assumed	.265	607	1.061	114	.291	2.52386	2.37798	2.18609	7.23461
	Equal Variance not assumed			1.095	59.838	.278	2.52386	2.30385	2.08479	7.13250

One-way ANOVA

In order to find the difference between other variables like sex of the animal, breed and types of animal the following ANOVA result on table 4 is presented.

Growth rate ANOVA			Sum of squares	df	Mean square	F	Sig
Between group	(combined)		3370.233	2	1685.117	16.254	.000
	Linear	Unweighted	3296.795	1	3296.795	31.799	.000
	Terms	Weighted	3222.235	1	3222.235	31.080	.000
		Deviation	147.998	1	147.998	1.428	.235
Within group			11715.336	113	103.676		
Total			**15085.569**	**115**			

Table 5 Bonferroni post HOC test in terms of growth rate among animal species fed with cassava peel waste ingredients.

1 species	1 species	Mean difference	Std Error	sig
Cattle	Goat	4.93321	2. 22619	.086
	Sheep	14.41793	2. 55679	.000
Goat	Cattle	-4. 93321	2. 22619	.086
	Sheep	9.48473	2. 35983	.000
Sheep	Goat	-4. 41793	2. 55679	.000
	Cattle	-9.48473	2. 35983	.000

Table 5 and 6 above present the result on the ANOVA carried on the difference in weight gain among species of animal fed with cassava peel waste (cattle, goat and sheep) the result (.000/F=16.2) indicate significance difference among the animal species with little deviation (.23) among the group Bonferroni post HOC test confirms the significance (0.00) highest mean deviation between cattle and sheep (14.4) and lowest between sheep and goat (-4.9) which translate that cattle gain more weight when fed with cassava peel where as the gap between goat and sheep is not much in term of weight gain.

Table 6 t-test analysis showing the difference in the environmental condition of the college of education Katsina-Ala as a result of the conversion of the cassava peels to livestock feed ingredient.

Environmental sustainability indicators

Air/water pollution reduction	N	$\overline{X}$	SD	Df	t-cal	-t-cri	p-value
Pre conversion	106	20.28	3.01				
Post conversion	134	22.03	4.22	239	2.65	1.95	0.011

Table 6 shows that t-test analysis of the difference in the environmental sustainability in terms of Air pollution and water use efficiency and pollution during the pre conversion period and after the conversion of the cassava peels to feed ingredient in the college. The table revealed that water in the college was cleaner and efficiently use after the conversion x=22.03 than the pre conversion period x=20.28. The t-test analysis shows that, t-calculated (2.65) was greater than the t-critical (1.95) at 238 degree of freedom and 0.11 significant levels. This shows that the conversion provide more effective and efficient environmental condition in the college of

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education Katsina-Ala. Therefore the null hypothesis which states that the conversion of cassava peel waste in the college of education Katsina-Ala has no impact on the college environment was rejected.

Table 8 t-test analysis showing the impact of the conversion of cassava peel waste into animal fed ingredient on college farm productivity in term of reduction in lost of feeding and weight gain

Farm productivity in respect to ruminant (cattle, sheep and goat) weight gain and cost save using cassava peel as major feed ingredient.

Ruminant weight cost saved	N	$\overline{X}$	SD	Df	t-cal	-t-cri	p-value
Pre- conversion period	73	17.72	4.43				
Post conversion period	107	20.29	3.05	1.76	3.35	1.96	0.02

Table7 presents the t-test analysis on the impact of the conversion of cassava peel waste into high quality feed ingredient on farm productivity and economic benefit to the college farm. The table revealed a t-calculated of 3.35 and t-crital value of 1.96 at 176 degree of freedom and 0.02 significant levels. The alpha value of 0.05 was found to be greater than the p-value of 0.02 which indicates that the conversion and use of cassava peel waste as animal feeds ingredient has effect on the productivity of the farm and also reduce feed cost during animal farm production. This implies that the conversion of the cassava peel waste into feed ingredient help save cost of production and increase animal weight gain. Therefore the null hypothesis which states that the conversion of cassava peel waste to high quality feed ingredient in college of education has no significant effect on the farm productivity was rejected.

Ho3: Educational outcome of the students are not significantly affected by the conversion of cassava peel waste into high quality feed ingredient in college of education Katsina-Ala.

Table 8 t-test analysis showing the difference in the impact of the conversion of cassava peel waste into high quality feed ingredient in college of education Katsina-Ala. Student engagement and knowledge assessment scores.

Student engagement and knowledge assessment scores.	N	$\overline{X}$	SD	Df	t-cal	-t-cri	p-value
Pre conversion	126	19.049	2.10168				
Post conversion	130	27.3171	3.44913	253	23.765	1.96	.00

Result in table indicate that the calculated t-value of 23.756 is greater than the critical t-value of 1.96 with degree of freedom 2.53 at significant thus the null hypothesis that the educational outcome of the student are not significantly improved as a result of the conversion was rejected. It was thus revealed that there exists significance in the educational outcome of the student following the conversion of the cassava peel waste to animal feed ingredients.

IV. Conclusion

Cassava peels despite having been regarded as a waste for ages, has a lot of values in compounding feed for domestic animals particularly when treated in order to reduce the hydrogen cyanide content. It is a good substitute energy source in the diet of farm animal. The conversion has positively impacted environmental sustainability, economic reforms and improve educational outcome of the students.

Recommendations

Base on the findings and conclusion of the study the following recommendations are given.

1. There is need for every high institution to embark on the conversion of cassava peel waste into high quality feed ingredients. This will help reduce the cost of animal production in agricultural education department.
2. There should be provision by government and private individual for training and retraining of individuals and teachers for them to be effective in the conversion processes.

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