AVAILABILITY AND YIELD OF PINEAPPLE PULP RESIDUE AS A POTENTIAL FEED INGREDIENT IN GHANA

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ABSTRACT

A survey was conducted to determine the availability and yield of pineapple pulp residue (PPR). It involved 100 pineapple farmers, located in the Eastern and Central Regions of Ghana, 16 pineapple processors, located in the Eastern, Central, Greater Accra and Ashanti Regions, and 13 pineapple waste collectors, located in the Greater Accra and Eastern Regions. It lasted 4 months and was carried out from November 2020 to February 2021. Well-structured questionnaires, made up of closed and open-ended questions were used. The questionnaire was first pre-tested one month before actual administration and administered using a face-to-face method. All survey respondents were purposively sampled. Analysis of the farmers' scale of operation revealed that only 6% of them were producing on an extra-large scale, i.e. above 100 metric tons per month; another 18% operated on a large scale (i.e. 51-100 metric tons per month) and the majority, 41% operated on a medium scale (i.e. producing 21-50 metric tons per month), the remainder who produced 1-20 metric tons per month constituted 35%, of the respondents. Of the processors surveyed, 31% of them operated at a medium scale of about 21-50MT per month. Those who operated on small (1-20MT) and extra-large scales (i.e. above 100MT) production per month respectively were 50% (25%each). The remaining 19% operated on a large scale (i.e. 51-100MT production per month). About 11 (73%), of the waste collectors, interviewed, indicated collection of pineapple waste 3 times or more per week though it was mostly paid for and also all 11 were collecting from Blue Skies Limited. Although 87% expressed satisfaction with the current quantities collected, 93% indicated their expectation to increase their requirement sooner or later. The study also revealed that for every given metric ton of fresh PPR, at least 8kg of dried PPR can be produced. In conclusion, PPR is available all year round although quantities differ depending on the time of the year, and it can readily be accessed for use as feed in monogastric livestock farming if found suitable.

Keywords: *Alternative feed ingredient, fruit wastes, pineapple pulp residue, processors*

INTRODUCTION

Presently, the increasing cost of farm animal production inputs globally and specifically in the tropics is very rapid, thus inflating the cost of producing kg of chicken and meat or meat products. Among the inputs, it is well known that the cost of feed is the major cost of animal production in the tropics. Feed cost in Ghana, as reported by Okai and Boateng (2007) represents between 70-80% of the total cost of production, especially when conventional ingredients are used. Therefore, this leads to higher production

cost, particularly for those operating animal enterprises like poultry and other farm animals commercially. Consequently, stakeholders of the poultry and livestock industry continue to rely on agro-industrial by-products (AIBPs) as an alternative feed resource. Agro-industrial by-products (AIBPs) particularly food and fruits wastes if given attention and value-added can help mitigate the huge costs associated with animal production. Leveraging AIBPs alone reduces the cost of feeding and degree of competition for feed and food ingredients between man and farm animals (Amoah *et al.,* 2018). This creates high cooperation within and between Ghana's agricultural sub-sectors.

Ghana's fruit crop sector over the past decades has contributed to the country's national development. The significance of the contribution by the sector to national development keeps increasing and cannot be ignored (Ofori-Appiah, 2018). The sector promises some hope as it produces some wastes. This is driven by change in consumption patterns and taste of Ghanaians from fizzy carbonated drinks to natural drinks and naturally produced fruit products. The ray of hope given by this sector can be found in the huge waste produced by the sector post-harvest and after processing. Industries like the Ekumfi Fruit Juice, Blue Skies, Nano foods (formerly Nsawam Cannery), Bomarts, New Age Ventures, KNUST Juice etc., produce wastes that can be used by the animal industry. In fact, for most of these processors, it costs them money to get rid of something that could be of so much benefit to a bleeding sub-sector like the animal sub-sector.

Pineapple clearly is one of the fruits utilized by the processors and for reasons of its high sugar content, it remains the single fruit that is mostly used by fruit processors. Although there is a decline in pineapple production from 43,461 tonnes in the 2015 production year to 27,148 tonnes in the 2016 production year (ISSER, 2017), the industry creates wastes at harvest, during and after processing, and consumption of pineapples. The wastes or by-products created by the industry are burnt, buried in pits or landfills or sent to refuse dumps. Value addition to these wastes by processing and the use of cheap processing methods like drying, fermenting and milling for inclusion in animal diets or at least feeding raw but fresh in some instance will help to cut down on the cost incurred in feeding animals in subsistence and commercial farming systems. The upsurge in fruit processing (juicing and drying), coupled with the increasing demand for processed fruit products, leads to the production of a lot of fruit wastes. The dominance by pineapple fruit, especially in the fruit juicing industry gives hope of the availability of pineapple pulp residue (PPR) in large quantities.

The objective of this study was to determine the availability and yield of pineapple pulp residue in some selected regions in Ghana.

MATERIALS AND METHODS

Description of study areas

The study was carried out in some districts noted for major pineapple growing and processing in the Ashanti, Greater Accra, Eastern and Central regions of Ghana from November, 2020 to February 2021. The districts were purposively selected after preliminary consultations with some district Directors of the Ministry of Food and Agriculture. They were Oduom, Kwabenya, Ekumfi and Fotobi within the Oforikrom, Ga East, Ekumfi Abor and Nsawam Adoagyiri Municipalities respectively.

Questionnaire development and administration

Well-structured farmer-specific, processor-specific, and waste collector-specific questionnaires, made up of closed and open-ended questions were designed. The questionnaires were designed with consideration to the respondents' convenience such that each questionnaire had not more than 20 questions. The farmer-specific questionnaire was first pre-tested in the Akuapem South and Awutu Senya Districts in the Eastern and Central Regions respectively one month before actual administration, with farmers who were not part of the research sample. Help-

ful comments from the pretesting were incorporated into the questionnaires to produce the final questionnaires, used for the study. The questionnaires were administered using a face-to-face method. One hundred purposively sampled farmers, 50 each from the Eastern and Central Regions were interviewed. Purposively sampled fruit processors numbering 16, located within the Eastern, Central, Greater Accra and Ashanti Regions were also interviewed and data collected. Data was also collected from 13 purposively sampled pineapple waste collectors located in the Eastern and Greater Accra Regions. It took about 15 to 20 minutes to administer each questionnaire. Few common questions that run through the 3 different questionnaires were;

1. Scale of operation of both farmers and processors

   Under this, small, medium, large and extra-large scales were defined for the purposes of the study as follows;

   i) Small (1-20MT per year)
   ii) Medium (21-50MT per year)
   iii) Large (51-100MT per year)
   iv) Extra-large (Above 100MT year)
2. Constraints to the operation and
3. The possibility of expanding operations etc.

Availability of PPR

Via administration of simple structured processor-specific questionnaires to 16 small, medium and large-scale pineapple processors located in the Eastern, Central, Greater Accra and Ashanti regions, knowledge about the availability of PPR was obtained.

$$\frac{\textit{Weight of pulp (kg)}}{\textit{Weight of whole fresh fruit (kg)}} = 100\%$$

Extraction rate of PPR

To be able to determine the amount of DPPR that can be obtained from a given weight of fresh pineapple fruits, PPR was extracted from 120 pineapple fruits of varying sizes, dried and weighed. It was determined by finding the weight of the dry pulp, divided it by the weight of the whole fresh fruit and multiplied the final figure by 100%.

Statistical Analysis

Data collected from the three categories of respondents were entered into Microsoft excel and then analysed using simple descriptive statistics (i.e., measures of frequency) following the procedure outlined by Statistical Package for Social Sciences (SPSS) version 26 (2019). Results obtained from the analysis were presented in tables and chart as frequencies and percentages.

RESULTS AND DISCUSSION

RESPONSES FROM FARMERS

Scale of operation

Of the 100 farmers surveyed for this study as indicated earlier, 50% each came from the Eastern and Central Regions of Ghana. Analysis of their scale of operation revealed (Figure 1), that

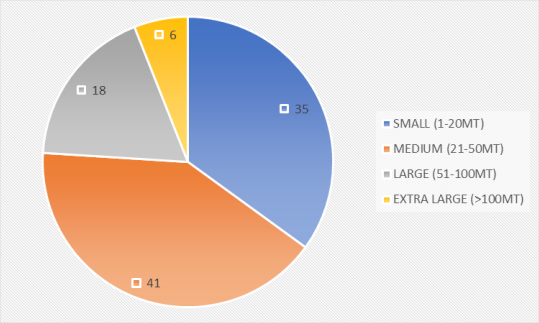

Figure 1: Scale of operation by farmers

only 6% of them were producing on an extra-large scale, i.e., above 100 metric tons per year; another 18% operated on large scale (i.e. 51-100 metric tons per year) and the majority, (41%) operated on a medium scale i.e. producing 21-50 metric tons, the remainder who produced 1-20 metric tons per year constituted 35%, of the respondents. These findings agree with the report by FAO (2020) that about 60% of all farms in the country are less than 1.2 hectares in size. With pineapple, one is expected to make a yield range of about 30 – 45 metric tons per acre. The

result of this study indicates that majority of farmers (predominantly smallholders) cultivate 1acre or less.

Reason(s) for producing specific varieties and Dominant variety produced

For reasons of availability and accessibility, 92% of them produced only pineapple, with Sugar Loaf (SL) being the dominant variety followed by Smooth Cayenne (SC) and MD2. These findings contradict an earlier report by TechnoServe (1998) that positioned SC as the most cultivated variety in Ghana. The findings can be attributed to the switch in variety from SC to MD2 in 2008 which contributed to farmers neglecting the SC variety, hence the current shortage of planting materials of the SC variety.

Based on the results of the study, as seen in Table 1, as high as 55% of the farmers produced Sugar Loaf. This was followed by SC (34%) and MD2 (11%). This contradicts the findings of Morgane and Chritophe (2005), which reported SC as the highest produced variety. The production cost for an acre of pineapple was higher for MD2 (GH¢15,000.00). This variety is highly susceptible to diseases and planting materials are often scarce. Smooth Cayenne is equally expensive to produce but less expensive (GH¢ 12,500.00) compared to MD2. The planting materials for SC is however scarcer than MD2, though SC tougher and has a better resistance against drought and diseases. Sugar Loaf remains the most resistant variety to drought and diseases, cheaper to produce per acre (GH¢ 10,000.00) and planting materials are readily available.

It is also the most commonly consumed variety on the local Ghanaian market. Technical knowledge for SL and SC production abounds but this is scarce for the MD2 variety and this is confirmed by the findings of Rahman (2002) that higher production efficiency levels were obtained by farmers with higher levels of experience. The high susceptibility of the MD2 variety to diseases, low technical knowledge and high cost of production are the main reasons for the low MD2 production levels.

Buyers

Processors and the open local market fruit vendors, who together make up 55% of buyers (Table 1), remain the major buyers of the pine-

Table 1: Results from 100 pineapple farmers' survey

Parameter	Frequency	(%)
Type of fruit produced		
Only Pineapple	92	92
Pineapple and other fruits	8	8
Reason for producing specific variety		
Availability	36	36
Accessibility	20	20
Cost	2	2
Quality	3	3
Others	39	39
Dominant variety		
SC	34	34
MD2	11	11
SL	55	55
Buyers		
Processors only	37	37
Exporters only	4	4
Local Market only	2	2
Processors and Exporters	2	2
Processors and Local Market	53	53
All buyer types	2	2
Key Challenges		
Input cost	13	13
Land acquisition by real estate owners	13	13
Credit accessibility	6	6
Labour	4	4
Diseases	41	41
Market	9	9
[1]Others	14	14
Expansion		
Yes	99	99
No	1	1

[1]*Transportation and poor road network, difficulty in accessing certificates to trade on some markets, etc.*

apples in both regions. This is of relevance to the study because the bulk of pineapple waste, particularly pulp residues are produced by processors. The period from February to May, and October to December, came out as the peak seasons for pineapple production whereas January, and the period from June to August turned out to be the lean season. The export market has a very strong effect on Ghana's pineapple value chain and this is supported by the findings of Asare (2012), who stated that pineapple on the European market is an off-season fruit and has October to December, and February to May as peak. This also supports the findings of Morgane and Chritophe (2005), who reported that April is the peak pineapple production month but June to September are lean months for production. Locally, the two major Christian festivals, Easter and Christmas fall within the peak period recorded by the survey hence the results observed.

Key challenges

Of great importance to the study is how pineapple wastes are disposed by the farmers. Most wastes according to the farmers are used as compost or mulch but some farmers burn them. Rotten fruits were mostly either buried in the soil, sent to refuse dumps or burned by farmers, by allowing the waste to dry, heaping and setting fire to it.

Diseases emerged as the major challenge to pineapple production followed by high cost of inputs and acquisition of farmlands by estate developers for real estate. Diseases have, for over a decade been a setback to the industry (Ablorh, personal communication). The dominant districts of pineapple production in the Eastern and Central regions where the bulk of pineapple in Ghana is produced are competing with real estate developers. This has caused acquisition and a takeover of most farm lands by developers. The prediction and finding of Theophilus (2014) about access to land and scarcity due to urbanization and real estate development, buttresses the findings of this study (Table 1), where 13% of challenges are as a result of acquisition of farm lands by real estate developers for residential purposes.

Expansion plans

In spite of the challenges reported by farmers in the study, Table 1 clearly indicates that 99% of the farmers indicated willingness to expand their production. For them, although there were challenges, yet the business was profitable. This however disagrees with the findings of Abbey (2005), who observed that farmers felt there was no point expanding farming operations since prices offered them by buyers were low.

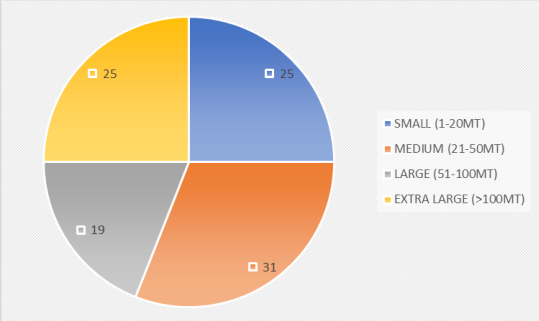

Figure 2: Scale of operations of processors

RESPONSES FROM PROCESSORS

Scale of operation

As indicated earlier, 16 pineapple fruit processors were purposively sampled for the study. As seen in Figure 2, (31%) of them operated on a medium scale of about 21-50MT per month. Those who operated on small (1-20MT) and extra-large scales (i.e. above 100MT) production per month respectively were 50% (25% each). The remaining 19% operated on a large scale i.e. 51-100MT production per month. The extra-large scale processors in the study are giant value chain actors, who clearly sold the bulk of their products on the international market hence the volumes. For most of the medium scale processors, they did not trade beyond Ghana but traded across regions.

Table 2: Results for Processors' Survey

Parameter	Frequency	(%)
Commodity		
Only Pineapple	2	12.5
Pineapple and other fruits	14	87.5
Varieties Processed		
One	2	12.5
Combination (More than one variety)	14	87.5
Dominant variety		
SC	5	31
MD2	6	38
SL	4	25
More than one	1	6
Monthly Processed Volumes		
1-1.9MT	2	12.5
2-2.9MT	2	12.5
3-3.9MT	1	6.
Above 5MT	11	69
Destination Market		
Only Ghana	11	69
Ghana and Europe	2	13
[2]Others	1	6
Only Europe	1	6
[3]All	1	6
Peak Season		
October-December	14	88
May-September	1	12
Lean Season		
June-August	11	69
January	5	31
Disposal of wastes		
Composting	19	59.0
Burying	1	3.0
Refuse dumping	5	16.0
Collected by farmers	7	22.0
Key challenges		
Unavailability of pineapple all year round	8	50.0
Scarcity of bottles and crown corks	2	12.5
Poor brix	2	12.5
Waste disposal	2	12.5
Scarcity of fruits and machinery	2	12.5
Expansion		
Yes	14	87.5
No	2	12.5

[2]*Other African countries, America and Asia*
[3]*Ghana, other African countries, Europe, America and Asia*

Dominant variety

Overall, 12.5% processed only pineapple fruit and one variety (SL) while 87.5% processed a mixture of pineapples (SL, SC and MD2 varieties) and other fruits. As shown in Table 2, the MD2 variety dominated the processing with about 38% followed by SC, 31% and SL, 25% and the main reasons were for quality and demand by end users. The aroma and juiciness associated with the MD2 also makes it a preferred variety in fruit juices (Wardy *et al.,* 2009)

Destination market

Most of the processors sourced their fruits from within their operational regions as well as other regions in Ghana. From the study (Table 2), 69% have Ghana as the final destination market for their processed fruits while 13% sold their products on the Ghanaian and European markets. Interestingly 6% sold their processed pineapple fruits only on the European market. These findings do not tally with the report by Morgane and Chritophe (2005), where export was the main and sole driver of the Ghanaian pineapple market in 2004. The report also positioned the private sector as the main driver of the pineapple supply chain and this tallies with findings of the current study.

Almost all processors indicated plans to sell beyond the Ghanaian market but for most of them, there abound so much market in Ghana that, not until the demand for the local Ghanaian market has been met, it will not make economic sense to go beyond Ghana.

Peak and Lean seasons

October-December emerged as the peak production season for 88% of the processors while 12% sold their products all-year-round, although the period between May and September also recorded high production. This is in line with the findings by Asare (2012) that pineapple on the European market is an off-season fruit and has October to December, and February to May as peak seasons. June-August was recorded by 69% of the processors as their lean processing season while 31% described January as their lean season.

Disposal of wastes

Disposal of the wastes and pulp residues was key to the study and for the processors, 22% indicated that farmers collected them on a weekly-to-monthly basis from the processing site.

Interestingly 16% actually paid to get them dumped or picked up by waste collection companies, 59% composted while the remaining 3% buried their waste in the soil and landfills. This corroborates the report of Nawirska and Kwaśniewska (2005), that disposal of fruit and vegetable waste in the past was mainly into municipal waste streams and landfills

Key Challenges

One of the prominent constraints to the pineapple processing venture was the unavailability of ripe fruits, as 50%, lamented about the unavailability of pineapples all-year-round (Table 2). This was confirmed by Ablorh (personal communication), who works as the head of agronomy for Blue Skies Company Limited.

For reasons of high demand, availability of market and profitability, 87.5% indicated their willingness and ever readiness to expand their operations. The constraints associated with pineapple waste and pulp residue disposal by farmers and processors sheds light on the availability of the pulp residue for use by livestock farmers, particularly those into piggery.

PINEAPPLE WASTE COLLECTORS

Pineapple waste collectors, who are active, at the end of the processing supply chain, were engaged to better understand issues surrounding pineapple waste collection. Of the 15 waste collectors surveyed, 14 (93%) came from the Greater Accra Region while 1 (7%) came from the Eastern Region. Eighty-seven percent of them were full-time livestock farmers whereas 13% operated as livestock and crop farmers. Only 2 (13%) fed the waste to monogastric livestock animals including pigs while the rest fed the wastes to other livestock animals excluding pigs although one of them indicated composting the waste. This was confirmed by Ablorh (personal communication) that cattle and sheep farmers from the Greater Accra Region always queue to buy the pineapple waste to feed their animals. About 11 of them (73%), indicated collection of pineapple waste 3 times or more per week. For those who collected their wastes from Blue Skies, they paid money for any quantities they collected. Active pineapple waste collection according to the collectors had been going on for about a decade now but the last 4 years have seen an increase in the numbers and frequency of collection. Although 87% expressed satisfaction with current quantities collected, 93% indicated their expectation to increase their requirement sooner or later. About half of the total waste collectors interviewed were quick to add that there were constraints to the waste collection and hoped that things will change for the best in future.

Extraction Rate

It was discovered at the end of the study that for every given metric ton of fresh PPR, at least 8kg (0.8%) of DPPR can be produced. This applies to all the three common varieties earlier mentioned, that is, SC, MD2 and SL. Based on the findings of this study, it could be inferred that between 960,000 kg to 1,200,000 kg of DPPR can be produced yearly. Kleeman's (2011) report, stated that, Ghana produces 120,000 – 150,000 metric tons of pineapple yearly. This finding on extraction rate is key to the study because, not until it has been well established that sufficient amount of pineapple is produced in Ghana, it will not be sustainable and economically feasible to include PPR in animal diets. This also supports the earlier finding by this study, of availability of pineapples all-year-round.

CONCLUSION

From the study, pineapple wastes (including pulp residue) are generated not only by fruit processors but also farmers. It was also established that there is little or no value addition to the waste generated. Processors and farmers also expressed worry about waste disposal and the

fact that it remains one of the topmost challenges to their operations. Despite the challenges, processors and farmers seek to expand their operations. The expansion is necessitated and driven by the profitable nature of their businesses. Their quest to expand operations and increase production volumes suggests generation of abundance of waste and pulp residue in the short to medium term. Fruit waste collectors who particularly farm cattle, sheep and goats, and located mainly in the Greater Accra Region, were discovered to be regular collectors of pineapple waste including the pulp residue. Apart from Blue Skies that took a little fee from waste collectors, and also has a compost recycling facility, all other pineapple processors struggle to dispose of their pineapple wastes. For most of them, it costs them money to dispose of the waste and if they had anyone collecting it at no cost, their operations would be enhanced. This creates opportunities for livestock farmers to access pineapple waste, particularly the pulp residue to feed their farm animals.

REFERENCES

Abbey, A. (2005). The Effect of Pineapple Farming on the Livelihood of Pineapple Farmers in the Ga Districts. https://www.semanticscholar.org/paper/The-Effect-of-Pineapple-Farming-on-The-Livelihood-Abbey/2015ed85c6b6cff264f87d8321f97c5d551ee0a8. 20th November 2021.

Amoah, K.O., Boateng, M., Okai, D.B. and Frimpong, Y.O. (2018). Anti-nutritional factors and their relevance to monogastric animal agriculture in Ghana: some important considerations. *Ghanaian Journal of Animal Science*, 9(2): 1-15.

Asare, R. (2012). Comparative Assessment of Quality of Fruit Juice from three Different varieties of Pineapples grown in Ghana. MSc. Thesis Post-Harvest Technology. KNUST. Pp. 9-16.

FAO (2020). World Programme for the Census of Agriculture 2020. Volume 2: Detailed Operational Guidelines. https://www.fao.org/food-agriculture-statistics/en/

ISSER (2017). The State of the Ghanaian Economy in 2016. Institute of Statistical, Social and Economic Research, October 2017. Isser, 246.

Kleemann, L. (2011). Organic pineapple farming in Ghana: A Good choice for smallholders? Kiel Working Paper No. 1671. Kiel, Germany: Kiel Institute for the World Economy.

Morgane, D. and Christophe, R. (2005). The rise of Ghana's pineapple industry from successful take-off to sustainable expansion. World Bank African Region, Working paper series No. 93, Pp-17-39

Nawirska, A. and Kwaśniewska, M. (2005). Dietary fibre fractions from fruit and vegetable processing waste. *Food Chemistry*, 91 (2): 221–225.

Ofori-Appiah, Y. (2018). Production Efficiency Analysis of Pineapple Farmers in the Akwapim-South District of Ghana. M. Phil. Thesis, Agricultural Economics and Agribusiness. University of Ghana, pp. 6-12 Unpublished.

Okai, D.B. and Boateng, M. (2007). Pig nutrition research in Ghana- Some achievements, prospects and challenges. *Ghanaian Journal of Animal Science*, 2 and 3(1): 19-25.

Rahman, S. (2002). Profit efficiency among Bangladesh rice farmers: University of Manchester. School of Economic Studies. Discussion Paper Series No. 0203.

TechnoServe (1998). 'Survey of Pineapple Production in the Akuapim South District of Ghana'. TechnoServe Report, Accra, Ghana

Wardy, W., Saalia, F.K., Steiner-Asiedu, M., Budu, A.S. and Sefa-Dedeh, S. (2009). A comparison of some physical, chemical and sensory attributes of three pineapple (*Ananas comosus*) varieties grown in Ghana. *African Journal of Agriculture and Food Security*, 8(5): 1-6.