Performance and carcass quality of broiler chickens fed diet containing pineapple waste meal fermented by “ragi tape”

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Abstract. The study was conducted to determine the effect of pineapple waste meal fermented by “ragi tape” (FPW) in diets on the performance and carcass quality of broilers. The “ragi tape” was a traditional commercial product of yeast. Five dietary treatments containing 0, 5, 10, 15 and 20% levels of FPW with four replicates were fed to 250 broiler chickens for 42 days in a completely randomized design. Feed and water were provided ad libitum. The variables were performance parameters and carcass quality. Results showed that the performance in finisher, carcass percentage and abdominal fat percentage were significantly affected by dietary treatments. Carcass percentage and abdominal fat percentage were significantly decrease in the proportion of 20% of FPW. However, the carcass percentage in treatments R0 – R4 were still in a good category. The higher the levels of FPW the lower the abdominal fat percentage signed that FPW treatments up to 20% resulted good category of broiler carcass. Income over feed cost and broiler cost analysis in 20% FPW treatment obtained the highest income and the lowest was 0% FPW treatment. It can be concluded that FPW can be fed to broiler chickens at up to 20% level.

Keywords: Broiler, Carcass, Fermentation, Performance, Pineapple

1. Introduction

Nutritionist in recent time have been focused in research of agro-industrial wastes in animal nutrition especially for monogastric animals. In fact, many feeds that can be fed alternatively at cheaper cost to monogastric livestock are based on the use of agro-industrial waste that are of no food value to humans [1]. Onwuka, et al. [2] stated that a major strategy to develop the livestock industry in developing countries could be the use of agricultural by-products like pineapple waste, corn cobs and brewers dry grain. Pineapple waste is agro-by-products from pineapple fruit.

Pineapple waste occurs as pineapple peels and core, making about 40-50% of the fresh fruit [3]. It contains mainly the sugars of sucrose, fructose and glucose [4]. Also, it contains low amounts of protein, fat, ash [5]. Pineapple peel is rich in cellulose, hemicellulose and other carbohydrates. Raw pineapple waste (on DM basis) contains about 4% crude protein, 60–72% NDF, 40–75% soluble sugars (70% sucrose, 20% glucose and 10% fructose) as well as pectin, but it is poor in minerals [6, 7], except Ca. It is locally available.

Traditional market wastes and restaurant wastes of agro-product like pineapple fruit represent a serious problem since it is usually causes major environmental problems. The process of pineapple to juice and dried pineapple fruits release in significant quantities of by-products, such as: peels, crowns and hearts. Nurhayati [8] reported that pineapple peel is produced from pineapple fruit processing. Approximately 27% of pineapple fruit is pineapple peel. The accumulation of pineapple
waste in the neighbourhoods constitutes a source of environmental pollution. If fresh pineapple peels are not consumed, it often gets mouldy and sour, and therefore unlike heptonly to be used as an animal feedstuff. Therefore, some studies were conducted to develop a procedure for converting pineapple waste into animal feed [9, 10].

Problems related with the fresh form, were overcome by the sun drying technique of pineapple peels developed by Aboh, et al. [11]. It gave dried peels of good quality, however, the dried peels are too compact and hard for its ingestion by animals. Researchers reported that pineapple wastes have been described as equivalent to cereal grains for ruminants [6] or as a low-nutrient feed [12].

Pineapple wastes are recommended as tremendous sources of organic raw materials and are potentially available for conversion into useful products such as animal feeds [13]. However there is a constraint to use it as poultry feedstuff due to it contains 19.8% of cellulose and 11.7% of hemicelluloses [14]. Therefore, to overcome this constraint, it is significant to explore some treatments to be applied to the peels such as crushing, to improve their ingestion without degrading the feedstuff value [11]. In any case, the high amount of fibre makes pineapple wastes more suitable to ruminants than to pigs and poultry. The bulkiness of the fresh products limits intake. Inclusion of 15 percent pineapple bran in chick diets depressed the feed conversion ratio and 20 percent inclusion decreased weight [15]. The final average live weight gains and feed conversion rate of growing rabbits significantly reduced as inclusion level of pineapple waste increased [16, 17]. However, Lamidi, et al. [18] found that broiler chickens could tolerate up to 10% pineapple waste in their diets without any deleterious effect. Olosunde [19] reported that sheep could tolerate up to 45% pineapple waste but 30% was superior when substituted for corn bran. Therefore, to overcome this constraint, it is significant to explore some treatments to be applied to the peels such as crushing, to improve their ingestion without degrading the feedstuff value.

It has been reported that pineapple waste contains high amounts of crude fiber and suitable sugars for growth of microorganisms. Similar to rice husk, pineapple peel also need pretreatment before offering to the poultry [13]. *Trichoderma harzianum* might be used to ferment agricultural by products those rich in fiber content to increase their quality by increasing crude protein content and reducing crude fiber content. Rice husk and pineapple peel had higher quality after fermenting with 12% of *Trichoderma harzianum*. Banana peel was not suggested to ferment with *Trichoderma harzianum* [20].

The use of microorganisms through fermentation to improve nutritional value of agro-industrial wastes, thereby offering the potential to make dramatic contributions to sustainable livestock production has been well documented [1, 21, 22]. The utilization of fungi for nutrient enhancement in agro-industrial waste by fermentation has been studied for years and their efficiency shown in substrates such as lignin, cellulose and hemicellulose polymers found in agro-industrial waste [23]. *Aspergillus niger* and *Trichoderma viride* have been successfully used in a number of fermentation studies towards solid waste management, biomass energy conservation and production of secondary metabolites in various agro-industrial wastes [24, 25, 26].

Some studies were conducted to develop a procedure for converting pineapple waste into animal feed [9, 10]. In studies by Correia, et al. [27], *Rhizopus oligosporous* was used to produce enhanced levels of free phenolics from pineapple residue in combination with soy flour as potential nitrogen source.

“Ragi tape” was a traditional commercial product contained *Candida parapsilosis, C. melini*, *C. lactosa, C. solani, Hansenula subpelliculosa, Rhizopus oligosporous, Aspergillus flavus, A. oryzae* and *Hansenula malanga* [28], that was could used to develop a procedure for converting pineapple waste into animal feed. However, there are no reported studies of the dietary of fermented pineapple waste in diet of broiler. This study aimed to investigate the effect of the dietary level of pineapple waste fermented by “ragi tape” on carcass percentage and abdominal fat percentage of broiler chickens.
2. Materials and Methods

2.1. Birds, Diets and Experimental Design

Fresh pineapple peels collected were washed and steamed for twenty five minutes. Then cooled and mixed with 30 g “ragi tape”/kg pineapple peels, incubated on three days at room temperature. “Ragi tape” was a traditional commercial product contained Candida parapsicosis, Candida melinis, Hansenula supbeliculosa, Hansenula malanga, Aspergillus niger, A. oryzae and Saccharomyces cerevisiae. Part of the fermented pineapple peels then were dried and ground to fine powder using mortar and pestle.

The PWF then incorporated into the experimental diets at five levels of 0, 5, 10 and 15 and 20%. Based diet and PWF were crushed to obtain diets R0, R1, R2, R3 and R4, respectively. The proximate analysis of fermented pineapple waste (PWF) was shown in Table 1. Based diet contain ingredients: yellow corn 55%, fish meal 12%, soybean cake 15%, rice bran 7%, coconut cake 10.5% and top mix 0.5%, and the nutrients composition is shown in Table 2.

A total of 250 unsexed broiler finisher (Cobb CP 707) have been used in this experiment. Birds were weighed and maintained under standar managerial practices. Feed and water were provided ad libitum throughout the experiment period, and these treatments were administrated for a 42 days period. Vaccination programme against Gumboro and ND were carried out as per schedule.

Parameters were evaluated: feed intake, weight gain, feed conversion ratio, carcass percentage and abdominal fat percentage. At 42 days the experiment, one representative bird from each pen was conventionally slaughtered by cervical dislocation, bled and eviscerated. Then, carcass parameters (ready to cook) including dressing percentage and abdominal fat were determined.

| Nutrients             | Unfermented PW | Fermented PW |
|-----------------------|----------------|--------------|
| Crude Protein (%)     | 0.92           | 7.87         |
| Crude Fiber (%)       | 18.25          | 17.42        |
| Fat (%)               | 0.80           | 1.53         |
| Ca (%)                | 0.58           | 12.73        |
| P (%)                 | 0.4            | 0.82         |
| GE (Kcal/kg)          | 2782           | 3830         |

Notes: PW = pineapple waste

| Treatments             | R0  | R1  | R2  | R3  | R4  |
|------------------------|-----|-----|-----|-----|-----|
| Based Diet             | 100 | 95  | 90  | 85  | 80  |
| Fermented Pineapple    | 0   | 5   | 10  | 15  | 20  |
| Calculated Analysis:   |     |     |     |     |     |
| Protein                | 21.85| 21.15| 20.45| 19.75| 19.05|
| Crude Fiber            | 4.86 | 5.48 | 6.11 | 6.74 | 7.37|
| Fat                    | 6.32 | 6.08 | 5.84 | 5.60 | 5.37|
| Ca                     | 2.31 | 2.83 | 3.35 | 3.87 | 4.40|
| P                      | 1.27 | 1.25 | 1.22 | 1.20 | 1.18|
| GE (Kcal/kg)           | 3883 | 3880 | 3878 | 3875 | 3872|
2.2. Statistical analysis

The data were subjected to analyze for a variance technique using completely randomized design that was employed in one-way analysis of variance, and significant differences compared by Duncan’s multiple range test [29]. All of statement of differences were performed at significance levels of 1% and 5%. The IBM SPSS Statistics 22 software was used for the statistical processing of data.

3. Results and Discussion

Data on performance and carcass quality of broilers affected by fermented pineapple waste (PWF) in diet is shown in Table 2. The results showed that carcass percentage and abdominal fat percentage were highly significant (P<0.01) affected by dietary treatments. Carcass percentage was significantly decrease in the proportion of 15% and 20% of PWF. However, the carcass percentage in treatments R0 – R4 were still in a good category. Abdominal fat percentage also was significant decrease in the proportion of 15% and 20% of PWF.

| Variable                  | Treatments          | SEM | P value |
|---------------------------|---------------------|-----|---------|
| Feed Intake (g/h/d)       |                     |     |         |
| Starter                   | 0% PWF              | 82.00 | .206   | .021   |
|                           | 10% PWF             | 80.60 | .016   | .007   |
|                           | 15% PWF             | 80.30 |         |         |
|                           | 20% PWF             | 80.65 |         |         |
|                           | 5% PWF              | 80.60 |         |         |
|                           | 10% PWF             | 80.60 |         |         |
|                           | 15% PWF             | 80.65 |         |         |
|                           | 20% PWF             | 80.65 |         |         |
|                           | 5% PWF              | 80.60 |         |         |
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|                           | 20% PWF             | 80.65 |         |         |
|                           | 5% PWF              | 80.60 |         |         |
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|                           | 15% PWF             | 80.65 |         |         |
|                           | 20% PWF             | 80.65 |         |         |
activity for cellulases and hemi-cellulases [23]. Additionally, \textit{T. viride} and \textit{A. niger} have found use in the production of extra cellular enzymes including cellulase, amylase and xylanase [32]. Mandey et al. [33] reported that carcass yield was significantly affected by the treatments, in which the carcass yield was highest from the birds fed diet containing 10% banana leaves fermented by \textit{Trichoderma viride} for 10 days (74.58%).

Fungi colonize substrates for utilization of available nutrients. They synthesize and excrete high quantities of hydrolytic extra cellular enzymes, which catalyze the breakdown of nutrients to products that enter the fungal mycelia across cell membrane to promote biosynthesis and fungal metabolic activities leading to growth [31]. Therefore, increase in the growth and proliferation of fungal biomass in the form of single cell protein (SCP) or microbial protein accounts for part of the increase in the protein content after fermentation [31].

The decreasing of abdominal fat in the present study may due to th Ca content and Ca : P balance in diet. Some reports suggest that high dietary Ca can adversely affect the utilization of fat [34], nitrogen and metabolisable energy [35] in broilers. Dietary Ca concentration had a significant effect on apparent fat digestibility. Fat digestibility was reduced by increasing Ca concentrations in all intestinal segments [36]. Aboh, \textit{et al.} [11] reported that ash, calcium and magnesium in sun dried pineapple peel were a useful mineral source for rabbits. In this experiment, the higher the levels of PWF the lower the abdominal fat percentage signed that PWF treatments up to 20% resulted good category of broiler carcass.

The significant increase in protein content of the pineapple waste after fermentation with “ragi tape” and the decrease in crude fiber concludes that fermentation of pineapple waste by “ragi tape” enriches the nutrient content of the waste and this by product can be good supplement in compounding animal feed provided that it is acceptable and highly digestible.

4. Conclusion

It can be concluded that fermented pineapple waste can be fed to broiler chickens at up to 20% level with a promising good category of broiler carcass and abdominal fat, although IOFCC was more higher.

5. References

[1] Iyayi E A and Fayoyin F K 2005. Effect of feeding cassava fruit coat meal on the nutrient digestibility and performance of broilers \textit{Livest. Res. for Rural Develop.} \textbf{17} (19)

[2] Onwuka C F I, Adejileye P O and Afolami C A 1997 Use of household wastes and crop residues in small ruminant feeding in Nigeria. \textit{Small Rum. Res.} \textbf{24} (3) 233-37

[3] Buckle K A 1989 Biotechnology opportunities in waste treatment and utilization for the food industries In: Rogers P. L. (Ed.) Biotechnology and the Food Industry. Breach Publishers, New York. p. 261-77

[4] Krueger D A, Krueger R G and Maciel J 1992 Composition of pineapple juice. \textit{J. of AOAC Int.} \textbf{75} 280-82

[5] Hebbar H U, Sumana B and Raghavarao K S M S 2008 Use of Reverse Micellar Systems for the Extraction and Purification of Bromelain from Pineapple Wastes \textit{J. of Bioresources Tech.} \textbf{99} (11) 4896-4902 doi:10.1016/j.biortech.2007.09.038.

[6] Müller Z O 1978 Feeding potential of pineapple waste for cattle \textit{Revue Mondiale de Zootecnie} \textbf{25} 25-9

[7] Pereira E S, Regadas Filho J G L, Freitas E R, Neiva J N M and Candid M J D 2009 Energetic value from by-product of the Brazil agroindustria \textit{Archivos de Zootecnia} \textbf{58} 455–58
[8] Nurhayati 2013 Penampilan Ayam Pedaging yang Mengkonsumsi Pakan Mengandung Tepung Kulit Nanas Disuplementasi dengan Yoghurt Agripet 13 (2) 15-20

[9] Makinde O A, Odeyinka S M and Ayandiran S K 2011 Simple and quick method for recycling pineapple waste into animal feed Livest. Res. for Rural Develop. 23 (9)

[10] Sruamsiri S, Silman P and Srimuch W 2007 Agro-industrial by-products as roughage source for beef cattle: Chemical composition, nutrient digestibility and energy values of··· leaves. Mj. Int. J. Sci. Tech. 9 88-94

[11] Aboh A B, Zoffoun G A, Djenontin A J P, Babatunde S and Mensah G A 2013 Effect of graded levels of dry pineapple peel on digestibility and growth performance of rabbit J. of Appl. Biosci. 67 5271-276

[12] Hepton A and Hodgson A S 2003 Processing. In: The Pineapple: Botany, Production and Uses. Bartholomew, D. P., R. E. Paul and K. G. Rohrbach (Eds), CABI Publishing.

[13] Hemalatha R and Anbuselvi S 2013 Physiochemical constituents of pineapple pulp and waste J. Chem. Pharm. Res. 5 (2) 240-42

[14] Bardiya N, Somayaji D and Khanna S 1996 Biomethanation of banana peel and pineapple waste Bioresource Tech. 58 (1) 73-76

[15] Hutagalung R I, Webb B H and Jalaludin S 1973 Evaluation of agricultural products and by-products as animal feeds 1. The nutritive value of pineapple bran for chicks Malaysian Agric. Res. 2 39-47

[16] Fapohunda J B, Iji O T, Makanjuola B A and Omole A J 2008 Effect of different levels of dry pineapple waste in the diet of growing rabbits Proc. 33rd Annual Conf. Nig. Soc. Anim. Prod. p. 195–98

[17] Adeyemi O A, Ajado A O, Okubanjio A O and Enilorunda O O 2010 Response of growing rabbits to graded levels of fermented and unfermented pineapple peel Ejeafche. 20 898-909

[18] Lamidi A W, Fanimo A O, Eruvbetine D and Biobaku W O 2008 Effect of graded levels of pineapple (Ananas comosus L. Meer) crush waste on the performance, carcass yield and blood parameters of broiler chicken Nig. J. Anim. Prod. 35 40-7

[19] Olosunde A O 2010 Utilization of pineapple waste as feed for West African Dwarf (WAD) sheep. M.Phil Thesis. Obafemi Awolowo University, Ile-Ife, Nigeria.

[20] Nurhayati and Nelwida 2014 Quality of Agricultural by Products Fermented by Trichoderma harzianum Agripet 14 (2)

[21] Iyaiy E A and Aderolu Z A 2004 Enhancement of the feeding value of some agro-industrial by-products for laying hens after their solid state fermentation with Trichodema viride Afr. J. Biotechnol. 3 (3) 182-85

[22] Fasuyi A O 2005 Maize-sorghum based brewery by product as an energy substitute in broiler starter. Effect on performance, carcass, characteristics organ and muscle growth Int. J. Poult. Sci. 4 (5) 334-38

[23] Howard R L, Abotsi E, Jansen van Rensburg E E L and Howard S 2003 Lignocellulose biotechnology: issues of bioconversion and enzyme production Afr. J. Biotechnol. 2(12) 602-19

[24] Omojasola P F, Jilani O P, Ibiyemi S A 2008 Cellulase production by some fungi cultured on pineapple waste Nature and Sci. 6 (2) 64-79

[25] Femi-Ola T O, Oluyege J O and Gbadebo A O 2009 Citric acid production from pineapple waste Continental J. Microbiol. 3 1-5

[26] Kareem S O, Akpan I and Alebiwu O O 2010 Production of citric acid by Aspergillus niger using pineapple waste Malaysian J. Microbiol. 6(2) 161-65

[27] Correia R T P, McCue P, Magalhaes M M A, Macedo G R and Shetty K 2004 Production of phenolic antioxidants by the solid-state bioconversion of pineapple waste mixed with soy flour using Rhizopus oligosporus Process Biochem. J. 39 2167-4902.
DOI:10.1016/j.procbio.2003.11.034

[28] Dwidjoseputro D 1981 Dasar-dasar Mikrobiologi Cetakan ke-5 Penerbit Jambatan

[29] Snedecor G W and Cochran W G 1967 Statistical Methods 6th Ed. Iowa State Univ. Press, Ames, IA.

[30] Omwango E O, Njagi E N M, Orinda G O and Wanjau R N 2013 Nutrient enrichment of pineapple waste using Aspergillus niger and Trichoderma viride by solid state fermentation. African J. of Biotech. 12 (43) 6193-196

[31] Raimbault M J 1998 General and microbiological aspects of solid substrate fermentation Electronic J. Biotechnol. 1 (3) 395-99

[32] Nair S C, Sindhu R, Shashidhar S 2008 Fungal xylanase production under solid state fermentation and submerged fermentation conditions Afr. J. Microbiol. Res. 2 082-86

[33] Mandey J S, Leke J R, Kaunang W B and Kowel Y H S 2015 Carcass yield of broiler chickens fed banana (Musa paradisiaca) leaves fermented with Trichoderma viride J. of the Indonesian Trop. Anim. Agric. 40(4) 229-33

[34] Sibbald I and Price K 1977 The effects of level of dietary inclusion and of calcium on the true metabolizable energy values of fats Poult. Sci. 56 2070-078

[35] Shafey T M and McDonald M W 1991 The effects of dietary calcium, phosphorus, and protein on the performance and nutrient utilization of broiler chickens. Poult. Sci. 70 548-53

[36] Mutucumarana R K, Ravindran V, Ravindran G and Cowieson A J 2014 Influence of dietary calcium concentration on the digestion of nutrients along the intestinal tract of broiler chickens. J. Poult. Sci. 51 392-401