Feed intake, growth and breast fillet sensory analysis of broiler chickens given drinking water with bio-organic supplements

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Abstract. Sixty, 14-days old unsexed broiler chicks were used to investigate the effects of using different bio-organic supplements at 2% inclusion to 1,000 mL drinking water on the growth performance and meat quality of broiler chickens with a feeding trial period of 3 weeks. The experiment was divided into 3 different dietary water treatment groups, namely: 980 mL water with 20 mL fermented fruit juice (FFJ), 980 mL water with 20 mL oriental herbal nutrients (OHN) and 980 mL water with 20 mL lactic acid bacteria serum (LABS). Plain water served as a controlled trial group. Each group was assigned into 3 replications, consisted of 5 birds each. Birds had *ad libitum* access to feed and water. Birds were studied by focusing on growth, feed utilization, carcass composition and meat quality. The supplementation of FFJ and OHN significantly increased daily feed intake in broiler chickens ($p<0.05$), compared with the LABS group. Additionally, OHN also resulted in much more tender meat ($p<0.05$). Furthermore, improvement in meat's over-all acceptability was observed in broilers given with FFJ and OHN. In conclusion, birds treated with FFJ resulted in a significant increase ($p<0.05$) in broilers feed intake. However, growth parameters were not affected by provisions of bio-organic supplements. Meanwhile, the OHN contributed towards an improvement of the sensorial characteristics of breast fillet described as more tender. Overall, the study indicates that FFJ and OHN can be used as a meat quality enhancer in broilers, which corresponds to moderately acceptable ($p<0.05$).

Key Words: beneficial microorganisms, fermentation, weight gain, growth performance, meat quality.

Introduction. Antibiotic resistance in food animals and antibiotic residues in meat products are two of the most pressing issues in meat production globally. Antibiotics are used to enhance growth and feed efficiency and are highly effective for maintaining flock health and reducing mortality (Yildirim et al 2013). The ban of antibiotic use and the threat of emerging pathogens pose significant challenges for the poultry industry, and poultry growers may welcome fermented plant products as natural substitutes to antibiotics. The issue even more complicates upon the persuasive public awareness on the effects of antibiotics on human health. Thus, alternative bio-organic supplements were explored to lessen if not eliminate antibiotic and its derivatives in animal diets.

Fermentation is the metabolic processes in which carbohydrates as well as some non-digestible poly- and oligosaccharides are partially oxidized with the release of the energy in the absence of any external electron acceptors. In broad terms, fermentation involves the use of microorganisms to carry out enzyme-catalyzed transformations of organic matter contributing to the development of characteristic properties in taste, aroma, texture, visual appearance, shelf life and safety (Holzapfel 2002).

Beneficial microorganisms including predominant populations of lactic acid bacteria and yeasts and smaller numbers of photosynthetic bacteria, actinomycetes and other types of organisms could be used. These are all mutually compatible and can coexist in fluid culture (Higa & Parr 1994). These beneficial microbes enter into the animal's intestines with feed and drinking water and then exclude the putrefying bacteria group in the intestines (Yongzhen & Weijiong 1995). Moreover, Dahal (1999) has concluded that the use of effective microorganisms is a safe technology that can be applied for promoting growth and for inducing immune response in broilers.

As an agent of change, it is a great challenge for the Authors to help farmers find alternative ways to promote good growth and improve gut-health in their reared animals, specifically birds. Hence, this study explored the possibility of using fermented bio-organic supplements by mixing with drinking water as supplements in broiler chickens.

Material and Method. Water and feed were offered *ad libitum* throughout the experimental period, which ended after 3 weeks. Broilers were grown according to the conventional way of growing commercial chickens starting from the brooding to the finishing stage. They were provided with uniform care and management like protection from any disturbance and stress. In consideration of the experimental animals' frail condition during brooding period which lasted up to 14 days, doses of antibiotic and vitamins were given for each treatment during the 1st three days and 7-9 days of the brooding period. Body weight and feed intake per cage were measured at the end of the experiment, and feed: gain was derived as the ratio of feed consumed to weight gain. In the final data gathering, the birds were fasted for 1 hour just like the traditional method of harvesting the broiler chickens.

Broiler facilities and equipment. Bird cages, space requirement, feeding and watering facilities were designed and constructed according to the structural and functional requirements recommendation of the Philippine Agricultural Engineering Standard (PAES 402:2001).

Broiler management and feeding. The experiment was carried out in accordance with the Code of Good Animal Husbandry Practices (GAHP) – Broilers and Layers (PNS/BAFPS 184:2016, ICS 65.030.20). To ensure the presence of adequate feeds, checking and refilling were regularly done three times a day.

The feeding was divided in two phases according to its nutrient requirement; 1-14 days (1st phase), chicks were given chick booster mash (Table 1) and from 15-35 days (2nd phase), they were given broiler starter crumble (Table 2).

Table 1

Ingredients and calculated guaranteed analysis of chick booster diets

	Ingredients	
Ground yellow corn	Brewer's dried yeast	Choline chloride
Cassava meal	Crude coconut oil	Vitamin premix
Soybean meal	Crude palm oil	Mineral premix
Full-fat soya	Molasses	Phytase enzyme
Rice bran	Limestone	Protease enzyme
Wheat pollard	Inorganic phosphates	Cellulase enzyme
Fish meal	Iodized salt	Xylanase enzyme
Pork meal	L-lysine	Toxin binders
Poultry meal	Lysine sulphate	Mold inhibitor
Meat and bone meal	DL-methionine	Antioxidants
Brewer's dried grains	L-threonine	
Guaranteed analysis[a]	*%*	*Relative quantities*
Crude protein, %	24.00	*min.*
Crude fat, %	3.00	*min.*
Crude fiber, %	5.00	*max.*
Ca, %	0.90	*min.*
P, %	0.55	*min.*
Moisture, %	12.00	*max.*

Source: Calculated according to B–MEG (2016). [a]Values from the feed company.

Table 2

Ingredients and calculated guaranteed analysis of broiler starter diets

Ingredients		
Ground yellow corn	Poultry meal	Lysine sulphate
Cassava meal	Feather meal	DL-methionine
Soybean meal	Meat and bone meal	L-threonine
Full-fat soya	Brewer's dried grains	Choline chloride
Rice bran	Brewer's dried yeast	Vitamin premix
Wheat pollard	Crude coconut oil	Mineral premix
Copra meal	Crude palm oil	Phytase enzyme
Corn germ meal	Palm olein oil	Protease enzyme
Corn gluten meal	Molasses	Cellulase enzyme
Corn gluten feed	Limestone	Mannanase enzyme
Corn bran	Inorganic phosphates	Toxin binders
Fish meal	Iodized salt	Mold inhibitor
Pork meal	L-lysine	Antioxidants
Guaranteed analysis[a]	*%*	*Relative quantities*
Crude Protein, %	21.00	*min.*
Crude fat, %	3.50	*min.*
Crude fiber, %	8.00	*max.*
Ca, %	0.90–1.10	*min.*
P, %	0.55	*min.*
Moisture, %	12.00	*max.*

Source: Calculated according to B–MEG (2016). [a]Values from the feed company.

Preparation of bio-organic supplements. All the necessary ingredients and materials were bought from reliable agriculture and veterinary supplies. The preparation of treatments was based on the Farmer's Guide on Bio-organic Inputs from Plants, Fish and Animal Liquid Extracts (DA-ATI-RTC-VIII, 2006).

Fermented fruit juice (FFJ). Ripe fruits were collected such as banana and papaya. These were finely cut/chopped into smaller pieces. Crude (muscovado) sugar and water at the ratio of 1:1:1 where mixed properly with the chopped fruits. The mixture was placed in a pail/container leaving 25% air space. This was covered with clean manila paper and was tied with plastic straw. The container was left undisturbed in a cool dry shady place for 10 days. Harvesting the FFJ liquid extract was made by straining with a mosquito net. The FFJ was then stored in a plastic bottle.

Oriental herbal nutrients (OHN). One kilo each of ginger, bulb onion and garlic were finely chopped. The chopped spices were transferred into a bamboo tube and were poured with 2 liters of coconut vinegar. The mixture was thoroughly mixed and covered with a clean manila paper and was tied with plastic straw. Preservation for a duration of 12 hours was made after which a kilo of muscovado sugar was added then again covered. The container was placed in a cool dry place away from direct sunlight. After 5 days of fermentation, beer was added. The cover was put back in place and returned to the storage area and retrieved after 7 days. The liquid from the container was strained and were placed in plastic bottles.

Lactic acid bacteria serum (LABS). Rice washing (or first two rinses of cloudy water) from rice before cooking was collected. A 50-70% air space or $^2/_3$ full with rice rinse-water in the container was provided. Loose covering of the container was done (not vacuum tight, allowing air pnetration into the container). The container was then placed in a cool area with no direct sunlight. Rice wash was fermented for 6 days at a temperature of 20-25^{0}C. After 7 days, rice bran floated like a thin film on the sour-smelling liquid was removed. The cloudy liquid (fermented rinse-water) was poured off discarding the mat layer and transferred into a bigger container. Ten parts of milk was poured (the original liquid has already been inoculated with different types of microorganisms including *Lactobacilli.* Saturation of milk will eliminate the other microorganisms and pure *Lactobacilli* will remain) to the strained sour-smelling liquid. Fermentation was done in 6 days. Carbohydrates, proteins and fat floated, leaving a yellow liquid (serum) fraction which contained the lactic acid bacteria. The pure lactic acid bacteria serum was loosely capped and stored in the refrigerator or simply added equal amount of crude sugar (muscovado) and diluted with $^1/_3$ water. Crude sugar kept the lactic acid bacteria alive at room temperature at 1:1 ratio serving as food for the bacteria.

Preparation and handling of meat quality. At the end of the experimental period, 12 randomly chosen broilers from 4 treatments were selected to evaluate meat quality characteristics. Chickens were humanely slaughtered by bleeding the left jugular vein. Subsequently, the chickens were immersed in hot water of 60–62°C for 80 s and their feathers were plucked. Head, viscera, and shanks were removed. The carcass was left for 1 h to remove excess water and then weighed. Carcass yield was calculated as carcass weight without the head, feet and neck determined immediately after evisceration relative to live weight. Meat quality was evaluated utilizing the breast part of the carcass.

Roasting of meat. The skin, along with subcutaneous fats and visible connective tissues, were excised from the breast before roasting. Breast fillet samples were sliced into 1.5 cm (0.6”) thick pieces and roasted in a preheated-oven (425°F/220°C) without flavoring and spices for about 18 min. until internal end-point temperature of 71–75°C, after which samples were provided to the sensory panel using a coded identifier.

Testing panel. A testing panel composed of two groups: three men and three women, all of whom were major trained students who were non-smokers, non-drinkers and with no false teeth. Before tasting, panelists were well instructed on the assessment criteria, meat attributes to be rated, and how to properly complete the questionnaire. Each coded sample was tasted by at least 3 different panelists. Room temperature water was provided to cleanse off flavor from the last taste and to neutralize sensory perception between samples. Panelists used a 5-point hedonic scale to assess meat quality attributes. Sensory-quality attributes being scored and described below.

Sensory evaluation

Odor. Sliced samples of the oven roasted breast part of the birds were placed in the coded plates for the evaluation of odor using the rating scale below:

Table 3

Odor evaluation of oven roasted part of experimental birds

Numerical rating	*Description*
4.51–5.00	Highly desirable chicken odor
3.51–4.50	Moderately desirable chicken odor
2.51–3.50	Normal chicken odor
1.51–2.50	Slightly undesirable chicken odor
0.50–1.50	Extremely undesirable chicken odor

Texture. Sliced samples of the oven roasted breast part of the birds were placed in coded plates for the evaluation of meat texture- the experience during chewing following the rating scale below:

Table 4

Meat texture evaluation of oven roasted part of experimental birds

Numerical rating	*Description*
4.51–5.00	Usually loose
3.51–4.50	Loose
2.51–3.50	Rigid
1.51–2.50	Moderately rigid
0.50–1.50	Extremely rigid

Flavor. Sliced samples of the oven roasted breast part of the birds were placed in the coded plates, tasted and evaluated by the members of the panel using the following scale below.

Table 5

Flavor evaluation of oven roasted part of experimental birds

Numerical rating	*Description*
4.51–5.00	Highly desirable chicken flavor
3.51–4.50	Moderately desirable chicken flavor
2.51–3.50	Normal chicken flavor
1.51–2.50	Slightly undesirable chicken flavor
0.50–1.50	Extremely undesirable chicken flavor

Tenderness. Sliced samples of the oven roasted breast part of the birds were placed in the coded plates to determine the tenderness of the meat. The lesser the number of chews before swallowing the more the tender was the meat. Rating was done using the scale below.

Table 6

Tenderness evaluation of oven roasted part of experimental birds

Numerical rating	*Description*	*Number of chews*
4.51–5.00	Very tender	1-5
3.51–4.50	Tender	6-10
2.51–3.50	Just tender	11-15
1.51–2.50	Tough	16-20
0.50–1.50	Very tough	21-25

Juiciness. Sliced samples of the roasted meat were placed on coded plates and evaluated by the testing panel to determine the moistness/juiciness of the roasted meat.

Table 7

Juiciness evaluation of oven roasted part of experimental birds

Numerical rating	*Description*
4.51–5.00	Extremely juicy
3.51–4.50	Moderately juicy
2.51–3.50	Juicy
1.51–2.50	Moderately dry
0.50–1.50	Extremely dry

Over-all acceptability. The ratings for the overall acceptability of the meat were based on the ratings from odor, texture, flavor, tenderness and juiciness. These numerical ratings generated were referred to the following description rating below:

Table 8

Over-all acceptability evaluation of oven roasted part of experimental birds

Numerical rating	*Description*
4.51–5.00	Very acceptable
3.51–4.50	Moderately acceptable
2.51–3.50	Just acceptable
1.51–2.50	Moderately undesirable
0.50–1.50	Extremely undesirable

Animals, treatment and experimental design. Sixty, 14-days old unsexed broiler chicks were distributed to 4 treatments replicated 3 times. Five broilers correspond to one replicate. The study was laid out in a Completely Randomized Design (CRD) with the experimental treatments as follows:
T1 = 1000 mL of water with 0 mL bio-organic supplement (control)
T2 = 980 mL of water with 20 mL Fermented Fruit Juice (FFJ)
T3 = 980 mL of water with 20 mL Oriental Herbal Nutrients (OHN)
T4 = 980 mL of water with 20 mL Lactic Acid Bacteria Serum (LABS)

Statistical analysis. All the data gathered were organized and analyzed statistically using the analysis of variance (ANOVA) of a Completely Randomized Design (CRD). Duncan's Multiple Range Test (DMRT) was used to compare treatment means showing significant differences.

Results and Discussion

Growth performance of broilers

Weight gain, and feed:gain ratio. Data on the growth response of the birds are presented in Table 9. The mean initial weight of birds used in the study was 49.60±0.18 g, mean final weight was 1,537.23±59.29 g and the mean daily gain was 42.51±1.69 g. During the 21-day trial, no significant differences were observed in the growth of broiler chickens treated or not with bio-organic supplements.

Table 9

Effects of different bio-organic supplements on the final weight, average daily gain (ADG), average daily feed intake (ADFI), feed intake:gain ratio of broilers (g)

Treatment	*Initial weight*	*Final weight*	*Daily gain*	*Daily feed intake*	*Feed intake:Gain ratio*
Control	49.40	1,549.53	42.86	113.01^{ab}	1.58
Bio-organic supplements*					
20 mL FFJ	49.80	1,606.47	44.48	116.74^{a}	1.58
20 mL OHN	49.70	1,530.20	42.30	115.95^{a}	1.64
20 mL LABS	49.50	1,462.73	40.38	110.55^{b}	1.65
Interaction	ns	ns	ns	*	ns

*Means in the same column with the same or no superscript are not significantly different at P>0.05 by DMRT, ns - not significant, * - significant (P<0.05).

It could be observed that in treated diets, feed intake was improved but offered no effect on weight gain. Though groups on treated diets did not differ significantly (p>0.05), it could be observed that birds' ate more tended to have achieved higher daily gain. It follows that given the same feeding period, the birds with higher daily gain would have higher final weight. On the other hand, there was no effect in treated groups on F:G ratio for the overall growth period (Table 9), though it tended to improve in broilers supplemented with FFJ. This result is in accordance with the findings of Gil et al (2015) that weight gain of broilers were not affected by the supplementation of probiotics in drinking water and O'Dea et al (2006) reported that supplementation of probiotics and those with prophylactic level of antibiotic supplementation did not enhance body weight of broilers. In contrast, Jaya (2019), who administered different levels of bio-organic supplements *via* drinking water, found significant effect on relative growth rate of broilers and Mgunda (2011) showed that effective microorganisms (EM) treated groups resulted to a higher body weight gain, cumulative body weight gain and average daily body weight gain. Moreover, it agreed to the findings of Higgins et al (2007) that the use of probiotics and EM could improve growth parameters such as feed intake, daily weight gain and feed conversion ratio in broilers. These disparate findings might be due to the variation in the experimental designs.

Feed intake. The feed intake of broilers for the overall period is shown in Table 9. Birds given two treated diets in T2 and T3 had a significantly higher feed intake ($p<0.05$), than those receiving the test diet in T4 with lower daily gain and higher F:G. The sweet taste of these treated diets might have influenced higher feed consumption of the experimental birds. In the conditions of this experiment, birds are observed to be much more sensitive to flavors in water treated diets. Hayes (2013) found out that chicken has taste buds on the tongue and can distinguish between different flavors where it prefers sweet and reject bitter taste. It agrees with the findings of Hof (2000) that birds prefer very much the sweet feed and those sweet tasting components significantly increase feed intake in animals and this fact is widely accepted. Furthermore, Roura et al (2012) reported that even though birds have a lower number of taste buds than mammals, the taste buds are relative to the potential bite size is still higher and it shows that chickens may have a higher sensitivity to bitter taste. Also supplementation of beneficial microorganisms gives favor to the birds by helping the animal through stimulating appetite and the immune system, improve microbial balance, produce digestive enzymes, decrease pH and release bacteriocins, and synthesize vitamins (Rowghani et al 2007).

Meat quality of broilers

Sensory-quality attributes. Results of sensorial quality evaluation of meat are shown in Table 10. It was observed that T3 had significantly higher tenderness scores ($p<0.05$) among treatments, suggesting that the achieved sensory tenderness of chicken breast fillet might be related to the effect of OHN. Wenk (2000) suggested that herbs and plant extracts contain bio-active ingredients such as alkaloids which may have helped tenderize meats. Interestingly, the results of the present study demonstrated that OHN was effective in improving the tenderness of breast meat. Meat tenderness has long been recognized as the most important quality trait for consumer acceptability of fresh meat (Mennecke et al 2007). On the other hand, the statistically significant effect of the FFJ and OHN on the improvement of overall acceptability was found ($p<0.05$). At present, panelist sensory results indicated higher overall liking for acceptability and tenderness of broiler breast fillet on a 5-point hedonic scale. This findings are in agreement with Bobko et al (2012) who was focused in different plant supplements for improving the sensory quality of chickens meat. On the contrary, there have also been similar study in which no positive results were found when broilers were supplemented with bio-organic supplements. For example, Jaya (2019) did not find any significant difference in meat tenderness and overall acceptability in broilers given water containing different kinds and levels of bio-organic supplements except for texture, odor, color and juiciness.

Table 10

Meat sensory attributes of broilers as affected by different bio-organic supplements

Treatment	*Dressed weight (g)*	*Dressing percentage, (%)*	*Odor*	*Texture*	*Flavor*	*Tenderness*	*Juiciness*	*Over-all acceptability*
Control	1,074.67	69.35	3.44	3.26	3.40	3.35^{b}	3.23	3.27^{b}
Bio-organic supplements*								
20 mL FFJ	1,138.00	70.84	3.41	3.28	3.21	3.58^{b}	3.18	3.66^{a}
20 mL OHN	1,087.36	71.06	3.69	3.34	3.27	4.20^{a}	3.64	3.85^{a}
20 mL LABS	1,023.62	69.98	3.58	3.22	3.35	3.28^{b}	3.08	3.20^{b}
Interaction	ns	ns	ns	ns	ns	*	ns	*

*Means in the same column with the same or no superscript are not significantly different at P>0.05 by DMRT, ns - not significant (P<0.05), * - significant (P<0.05).

In the current study, there was no influence of treated diets on dressed weight and dressing yield as interactions were similar among treatments (Table 10). The obtained results were in accordance with Jaya (2019) who found no significant differences in dressing percentage of broilers given treated diets containing different kinds of bio-organic supplements in the drinking water. Similarly, Sunder et al (2015) reported that fruit juice (noni) and LAB and their combination did not influence carcass yield significantly. However, all the treated diets showed higher dressing percentage compared to control group and the values observed in all treated diets were relatively closer to the common standards use range from 70-73% for full dressed chicken given the birds are around 35 to 38 days at harvest (PCAARRD 2010). Moreover, it is important to note that there are lots of factors that influence dressing percentage. These factors include growth rate, genetic background, size and age of bird and dressing techniques. Differences in these studies may be attributed to any of these factors.

Furthermore, treated diets did not influence carcass sensorial attributes ($p>0.05$) of odor, texture, flavor, and juiciness of breast meat. Figure 1 shows lower value of these attributes for all bioorganic-supplemented treatments. In line with these findings, the present data suggest that the use of bio-organic supplements administered *via* drinking water led to similar sensory quality attributes (odor, texture, flavor, and juiciness in particular), in relation to control group that received tap water. In assessing preference for products, the attitudes of consumers should not be ignored (Worch et al 2010). The panelists used in the study were mostly students, therefore, there is need to determine sensory characteristics across different age groups, to ascertain whether tenderness or any of the aforementioned traits could influence the overall acceptance during the tasting of chicken meat. In terms of phytogenic sources, the mechanism by which sensory attributes are improved has not yet been thoroughly investigated. However, in the present study, adding fermented bio-organic supplements to the drinking water of broiler chickens can be interpreted as a preliminary platform to observe meat quality improvements. Further investigations are needed to clarify these effects.

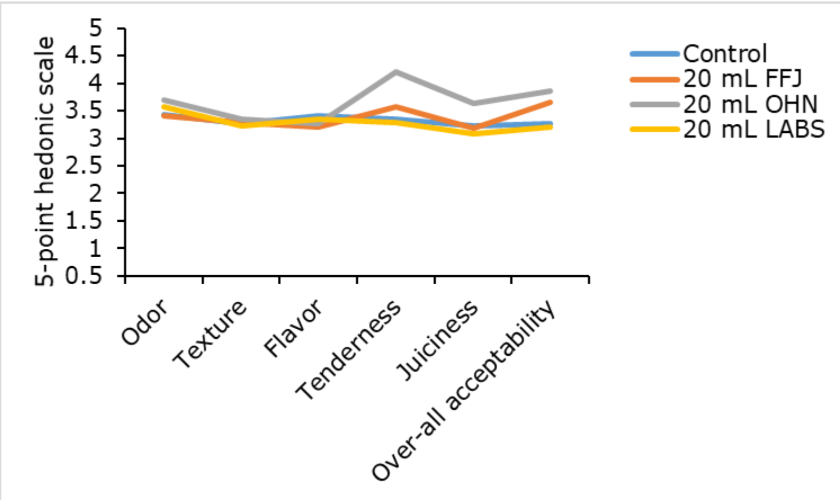

Figure 1. Interaction effect of different bio-organic supplements on meat sensory attributes of broilers.

Conclusions. Broilers that drink water supplemented with 20 mL FFJ, and 20 mL OHN have positive results in daily feed intake, and meat quality over-all acceptability. Meanwhile, the OHN contributed towards an improvement of the sensorial characteristics of breast fillet described as more tender. However, research carried out revealed no differences in growth rate, feed conversion efficiency, or feed:gain ratio, flavors, texture together with other sensory attributes among broilers given treated diets.

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References

Bobko M., Haščík P., Bobková A., Kňazovická V., Tóth T., Angelovičová M., 2012 Influence of different plant supplements applied in chicken nutrition on quality of their meat. Journal of Microbiology Biotechnology and Food Sciences 1:1020-1031.
Dahal B. K., 1999 Effective microorganisms (EM) for animal production. Institute of Agriculture and Animal Science, Rampur Campus, Chitwan, Nepal. Available at: http://www.emturkey.com.tr/eskisite/TR/dosya/1-434/h/effective-microorganisms-emfor-animal-production.pdf.
Gil N. C., Calva M. R., Hufalar A. M., 2015 Growth Performance of Broilers with Probiotic Supplementation. Journal Science, Engineering and Technology 3:36-45.
Hayes J., 2013 Anatomy and physiology of the chicken. SAPA. www.sapoultry.co.za.
Higa T., Parr J. F., 1994 Beneficial and effective microorganisms for a sustainable agriculture and environment. Int'l Nature Farming Research Center Atami, Japan. http://www.58294731NaturalFarmingManualCompleteimoothertechnique.pdf.
Higgins J. P., Higgins S. E., Salvador V., Wolfenden A. D., Tellez G., Hargis B. M., 2007 Temporal effects of lactic acid bacteria probiotic culture on salmonella in neonatal broilers. Poultry Science 86(8):1662-1666.
Hof C., 2000 Use of sweeteners in animal nutrition. Lohmann Information 24:27-31.
Holzapfel W. H., 2002 Appropriate starter culture technologies for small-scale fermentation in developing countries. International Journal of Food Microbiology 75(3):197-212.
Jaya A. F., 2019 Broiler performance and meat quality in response to different kinds and levels of bio-organic supplements. JPAIR Multidisciplinary Research 35:81-94.
Mennecke B. E., Townsend A. M., Hayes D. J., Lonergan S. M., 2007 A study of the factors that influence consumer attitudes toward beef products using the conjoint market analysis tool. Journal of Animal Science 85:2639-2659.
Mgunda H. D., 2011 Assessment of effects of effective microorganisms on broiler chicken performance and malodour reduction in poultry house. A dissertation submitted in partial fulfillment of the requirements for the degree of Master of Science in Tropical Animal Production of Sokoine University of Agriculture, Iran.
O'dea E. E., Fasenko G. M., Allison G. E., Korver D. R., Tannock G. W., Guan L. L., 2006 Investigating the effects of commercial probiotics on broiler chick quality and production efficiency. Poultry Science 85(10):1855-1863.
Roura E., Baldwin M. W., Klasing K. C., 2012 The avian taste system: Potential implications in poultry nutrition. Animal Feed Science and Technology 180(1-4):1-9. https://doi.org/10.1016/j.anifeedsci.2012.11.001.
Rowghani E., Arab M., Akbarian A., 2007 Effects of a probiotic and other feed additives on performance and immune response of broiler chicks. International Journal of Poultry Science 6(4):261-265.
Sunder J., Tamilvanan S., Kundu A., 2015 Efficacy of feeding of *Morinda citrifolia* fruit juice and *Lactobacillus acidophilus* in broiler. Asian Journal of Animal and Veterinary Advances 10(8):352-359.
Wenk C., 2000 Why all the discussion about herbs? Proceedings of Alltech's 16th Annual Symposium of Biotechnology in the Feed Industry. Lyons T. P. (ed), Alltech Tech. Publications, Nottingham, University Press, Nicholasville, KY, pp. 79-96.
Worch T., Lê S., Punter P., 2010 How reliable are the consumers? Comparison of sensory profiles from consumers and experts. Food Quality and Preference 21:309–318.
Yildirim A., Şekeroglu A., Eleroglu H., Şen M. I., Duman M., 2013 Effects of Korean (*Panax ginseng* C.A. Meyer) root extract on egg production performance and egg quality of laying hens. South African Journal of Animal Science 43:194-207.
Yongzhen N., Weijiong L., 1995 Effects of effective microorganisms (EM) on reduction of odour from animal and poultry dung. Proceedings of Fourth Conference on Effective Microorganisms, pp. 104-108.
*** DA-ATI-RTC-VIII, 2006 Farmer's guide on bio-organic inputs from plants, fish and animal liquid extracts. http://www.ati.da.gov.ph/rtc8.
*** B-MEG, 2016 Composition and analysis of commercial ration.

*** PAES, 402:2001 Philippine Agricultural Engineering Standard, Agricultural Structures – Housing For Broiler Production. https://docs.google.com/viewer?a=v&pid=sites &srcid=Y2Fyc3UuZWR1LnBof pvfGd4OjI4NDA2YmZlNTBlOThmYzk
*** PCAARRD, 2010 The Philippine recommends for broiler production. PCAARRD, Los Baños, Laguna. PCAARRD-Phil.Recommend series # 10 C, 74 p.
*** PNS/BAFPS, 184:2016, ICS 65.030.20 Philippine National Standard, Bureau of Agriculture and Fisheries Product Standards – Code of good animal husbandry practices (GAHP). http://www.bafps.da.gov.ph/2017-10-12-00-46-55/standard-formulation/philippine-national-standards?start=80.

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