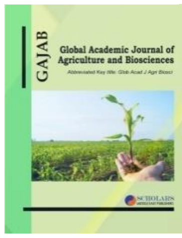
Global Academic Journal of Agriculture and Bio sciences

Available online at https://www.gajrc.com
DOI: 10.36348/gajab.2021.v03i06.001

OPEN ACCESS



ISSN:2706-8978 (P)
ISSN: 2707-2568 (O)

Original Research Article

The Effect of Fermented Shrimp Waste in the Ration on the Performance of Local Chickens

Abun Abun[1*], Tuti Widjastuti[2], and Kiki Haetami[3]
[1]Department of Animal Nutrition and Feed Technology, Padjadjaran University, Sumedang West Java, Indonesia
[2]Department of Animal Production, Padjadjaran University, Sumedang-West Java, Indonesia
[3]Department of Fisheries, Padjadjaran University, Sumedang-West Java, Indonesia

***Corresponding Author**
Abun Abun

Article History
Received: 09.10.2021
Accepted: 16.11.2021
Published: 14.12.2021

Abstract: Shrimp waste fermentation technology is a practical alternative solution; the results are preferred by livestock and can improve the nutritional quality to affect the quality of the ration. The provision of rations with good quality protein can affect the growth rate and development of local chickens. Local chicken is one type of local poultry that can produce eggs and meat so that the community widely cultivates it. The purpose of the study was to obtain the level of use of fermented shrimp waste in the ration that produced the best local chicken performance. The study used 125-day old local chicken chickens, divided into 25 cage units and each cage unit consisted of 5 chickens. Chickens were reared for eight weeks. The study used an experimental method with a completely randomized design, five types of ration treatments, namely R0 (the ration without the use of fermented shrimp waste), R1 (the ration containing 5% fermented shrimp waste), R2 (the ration containing 10% fermented shrimp waste), R3 (the ration containing 15% fermented shrimp waste), and R4 (the ration containing 20% fermented shrimp waste). Each treatment was repeated five times. Data were analysed using ANOVA, and differences between treatments were performed using Duncan's Multiple Range Test. The results showed that fermented shrimp waste (*Bacillus licheniformis, Lactobacillus* sp., and yeast *Saccharomyces cerevisiae*) up to 10% in the ration formula could utilize fish meal, and improve growth performance, as well as promote the best final weight in local chickens. Fermented shrimp waste can be used up to a level of 20% in the ration formula without affecting the performance of local chickens.

Keywords: Shrimp waste, fermentation, ration efficiency, local chicken, protein efficiency ratio, performance.

INTRODUCTION

Local chicken is one type of local poultry that can produce eggs and meat, so it is widely cultivated by the community, especially those who live in rural areas. This is because local chickens have good adaptations to the environment. Consumer demand for local chicken meat is increasing every year. Seeing this, farmers must pay attention to the speed of harvesting age from local chickens to meet the demands needed by the market by paying attention to the efficiency of the ration used in producing high body weight gain. Local chickens primarily consume rations to meet their protein and energy needs. The protein content in the ration is very influential on the achievement of body weight in local chickens. The protein content in the ration is needed for tissue growth, tissue repair, and production management and part of the enzyme structure so that protein is known as one of the main constituents of body cells and tissues [1-3]. This shows that protein plays an essential role in achieving the desired carcass weight [4].

The provision of rations with good protein quality will undoubtedly affect the growth and development of local chickens. The resulting body weight gain is an illustration of the quality of the ration given. The increase in body weight resulted from good quality rations. The quality of the protein ration will affect the intake of protein into the meat so that amino acids are fulfilled in the chicken's body. Bodyweight gain is caused directly by the availability of tissue-forming amino acids, so that the consumption of protein rations is directly related to the growth process [5]. The quality of protein is determined by the feed ingredients that make up the ration, especially the protein source feed ingredients used and have good nutrient content, namely fish meal. Fish meal has a high nutrient content, especially in protein content which can affect the quality of protein in chicken rations[6][7]. However, considering the high price of fish meal and limited availability, it is necessary to look for alternative feed ingredients for protein sources that are cheap, easy to obtain, abundantly available, and have reasonably high protein content and which are expected to match the quality of the ration from the use of fish meal, namely waste shrimp.

The amount of shrimp waste is increasing along with the increase in shrimp exports. The shrimp processing business in Indonesia has a production capacity of around 500,000 tons per year, of which 80-90% of the total shrimp production is exported in the form of frozen shrimp without heads and shells. This head and skin weight reaches 60 - 70% of the intact weight [3, 8-10]. The volume of shrimp head and shell waste produced can reach 203,403 - 325,000 tons per year. This amount represents excellent potential for the utilization of waste if it can be processed into alternative feed ingredients for protein sources for the composition of poultry rations. Shrimp waste has a high nutritional content, especially protein (42.65%) which is almost the same as fish meal and has a relatively low price. The obstacle in shrimp waste is the presence of a limiting factor in the form of chitin which binds to proteins and minerals in glycosidic covalent bonds. It is difficult to digest by poultry digestive enzymes. Therefore, it is necessary to make an effort to improve the quality so that it can be used as a feed ingredient in the preparation of poultry rations. One of the efforts to improve the quality of feed ingredients is biological processing through a gradual fermentation technique using *Bacillus licheniformis*, *Lactobacillus* sp., and yeast in the form of *Saccharomyces cerevisiae*. *Bacillus licheniformis* bacteria produce chitinase enzymes and protease enzymes with deproteination properties that will liberate some nitrogen or protein from chitin bonds [11–13]. *Lactobacillus* sp. functions to break down glucose, sucrose, maltose, and lactose so that mineral deposits occur [14–17]. *Saccharomyces cerevisiae* is a yeast that produces the enzyme amylase, lipase, protease, and other enzymes that can help the process of digestion of food substances in the digestive organs [18, 19].

Shrimp waste fermentation technology is a practical alternative. The results are highly favoured by livestock and cheap to increase the nutritional value, especially protein from the waste, so that it affects the protein quality of the ration. One way that can be used to assess the quality of the protein ration is to calculate the balance value of protein efficiency. Protein efficiency ratio (PER) is a method used to determine the quality of protein rations which are defined as body weight gain divided by protein consumed [20, 21]. The protein efficiency ratio determines the efficiency level of an animal in converting each gram of protein into many bodyweight growths [1, 22].

MATERIALS AND METHODS

The study used 125 local day-old chickens (DOC) without sex separation (straight run). DOC body weight has an average coefficient of variation of 7.53%. The cage used is cage-shaped, as many as 25 units with a length of 0.7 m, width 0.5 m, and height of 0.7 m. Each cage unit consists of 5 chicks and is equipped with a round feeder-shaped feeder and a round-water drinking container made of plastic, and a 15-watt incandescent lamp. Chicken rearing is carried out from the age of 1 day to 8 weeks, the provision of rations and drinking water is carried out ad-libitum.

The study was conducted by experimental method and using a completely randomized design (CRD) with five kinds of ration treatments and repeated five times. The treatment rations used in the study were rations without the use of fermented shrimp waste (R0), the ration containing 5% fermented shrimp waste (R1), the ration containing 10% fermented shrimp waste (R2), the ration containing 15% fermented shrimp waste (R3), the ration contains 20% fermented shrimp waste (R4). The ration is based on the crude protein content of 15% and metabolizable energy of 2,750 kcal/kg.

The nutrient content and metabolizable energy of the feed ingredients that make up the ration are presented in Table 1. The composition of the experimental ration used in the study is shown in Table 2. Based on the ration design, the nutrient content and metabolizable energy of the practical ration are presented in Table 3.

Table-1: Nutrient Content and Metabolizable Energy of Feed Ingredients for Ration

Feed Ingredients	ME**)	CP**)	EE**)	CF**)	Ca**)	P**)	Lys**)	Meth**)
	(kkal/kg)	……………………………………%………………………………						
FSW*)	2614	39.29	7.03	7.79	6.81	2.83	3.04	1.46
Rice bran	1630	12.00	13.00	12.00	0.12	0.21	0.71	0.27
Yellow corn	3370	8.60	3.90	2.00	0.02	0.10	0.20	0.18
Soybean meal	2240	44.00	0.90	6.00	0.32	0.29	2.90	0.65
Fish meal	2970	58.00	9.00	1.00	7.70	3.90	6.50	1.80
Bone meal	0	0	0	0	23,3	18.0	0	0
CaCO3	0	0	0	0	40.0	0	0	0

*)FSW, fermented shrimp waste

**)ME, metabolizable energy; CP, crude protein; EE, extract eter; Ca, calcium; P, phosporus; Lys, lysine; Meth, methionine

Table-2: Arrangement of Experimental Ration

Feed Ingredients	R0	R1	R2	R3	R4
	………………………………%………………………				
FSW*)	0.00	5.00	10.00	15.00	20.00
Rice bran	28.00	26.75	24.75	23.00	18.00
Yellow corn	58.00	58.00	58.00	58.00	60.00
Soybean meal	4.75	2.50	2.25	1.50	0.00
Fish meal	8.00	6.50	3.75	1.25	0.00
Bone meal	0.75	0.75	0.75	0.75	1.00
CaCO3	0.50	0.50	0.50	0.50	1.00
Amount	100	100	100	100	100

*)FSW, fermented shrimp waste

Table-3: Nutrient Content and Metabolizable Energy of Experimental Ration

Nutrient Content	R0	R1	R2	R3	R4	Necessity
Metabolizable energy (kkal/kg)	2,755	2,770	2,781	2,792	2,838	2,750
Crude protein (%)	15.08	15.03	15.05	15.03	15.18	15
Extract ether (%)	6.66	6.70	6.54	6.43	6.09	4.0-7.0
Crude fibre (%)	4.89	4.97	5.08	5.19	4.92	3.0-6.0
Calcium (%)	1.05	1.27	1.39	1.54	2.03	0.9-1.1
Phosphor (%)	0.58	0.65	0.68	0.72	0.84	0.7-0.9
Lysin (%)	0.97	0.95	0.90	0.86	0.86	0.8-1.0
Methionine (%)	0.35	0.38	0.40	0.42	0.45	0.38-0.42

R0 = Ration without the use of fermented shrimp waste
R1 = The ration contains 5% fermented shrimp waste
R2 = Ration contains 10% fermented shrimp waste
R3 = Ration contains 15% fermented shrimp waste
R4 = Ration contains 20% fermented shrimp waste

The observed variables include:
1. Initial bodyweight of chicken (g)
2. Final weight of chicken (g)
3. Consumption of rations (g)
4. Protein consumption (g): Feed consumption (g) × ration protein content (%)
5. Weight gain (g): Final body weight (g) - Initial body weight (g)
6. Feed conversion: Feed consumption (g) / weight gain (g)
7. Protein efficiency balance: Body weight gain (g) / Protein consumption (g)
8. Feed efficiency: weight gain (g) / ration consumption (g) × 100%

RESULTS AND DISCUSSION

The average results of the study were initial weight of chickens (g), final body weight of chickens (g), ration consumption (g), protein consumption (g), body weight gain (g), ration conversion, protein efficiency balance, and ration efficiency (%) of each treatment during the study are presented in Table 4.

Table-4: Average initial body weight, final body weight, ration consumption, protein consumption, body weight gain, ration conversion, protein efficiency balance, and local chicken ration efficiency.

Observed variables	Treatment				
	R0	R1	R2	R3	R4
Initial weight (g)	26.92±1.07	28.12±0.88	27.92±0.86	28.12±0.94	28.04±0.74
Final weight (g)	475.89±20.21 AB	503.72±22.63 A	486.61±39.43 A	442.62±42.44 BC	426.21±14.45 C
Feed intake (g)	1700.77±83.75	1858.89±149.97	1682.25±189.28	1602.32±247.58	1566.86±255.65
Protein intake (g)	256.48±12.63	279.39±22.54	253.18±28.49	240.83±37.21	237.85±38.81
Weight gain (g)	448.97±20.17 AB	475.60±22.34 A	458.69±39.37 A	414.50±41.71 BC	398.17±14.34 C
Feed conversion ratio	3.79±0.12	3.91±0.21	3.67±0.27	3.87±0.49	3.95±0.75
Protein efficiency ratio	1.75±0.06	1.71±0.09	1.82±0.13	1.74±0.22	1.71±0.29
Feed efficiency (%)	26.41±0.85	25.66±1.36	27.38±1.99	26.17±3.26	25.97±4.36

The results of the variance showed that the five treatment rations, both without the addition of fermented shrimp waste and those given fermented shrimp waste up to a level of 20%, did not have a significant effect (P>0.05) on Initial weight, ration consumption, protein consumption, feed conversion ratio, protein efficiency ratio, and ration efficiency. This means that the use of fermented shrimp waste flour in the chicken ration formula up to 20% did not significantly affect the performance of local chickens during the study, according to the opinion [23], [24], that the use of various levels of fermented shrimp waste in the ration did not show a significant difference between treatments on general performance. It was stated by [10, 24] that ration consumption was not significantly different in chickens fed with fermented shrimp waste flour in their ration mixture. The study results [25] proved that the use of fermented shrimp waste flour in the ration had an insignificant effect on the performance of chickens in general. The absence of a significant difference in performance from each treatment indicated that the chitin in the ration was still within the tolerance limit, so it did not affect the performance of the chickens during the study.

Shrimp waste treated by fermentation showed an increase in quality and palatability in the ration so that the amount of treatment ration consumption was not significantly different (P>0.05) with the ration without the use of fermented shrimp waste (R0). In line with the results of research [13, 26], that the processing of shrimp waste using the microorganism *Bacillus licheniformis* and yeast in the form of *Saccharomyces cerevisiae* makes protein independent of the limiting factor in the form of chitin, causing an increase in nutritional quality, namely the protein content in shrimp waste and increasing its palatability. Palatability of rations up to treatment R4 (20% addition of fermented shrimp waste) was not different from rations without fermented shrimp waste (R0). The use of fermented shrimp wastes up to a level of 20% in the ration formula gave the same average ration consumption, so that protein consumption also shared the same results. It was stated [27–29], poultry will consume protein along with the quantity of feed consumed. The mean protein consumption was not significant (P>0.05) because the energy and protein levels in the five treatment rations were the same. This causes protein consumption to be not significantly different (P>0.05) because protein consumption is influenced by energy and protein content in the ration. This statement is supported by the opinion [30, 31] that protein consumption is influenced by the content of metabolizable energy and protein rations. The same metabolizable energy given in the ration will result in the consumption of the same ration; in other words, the ration contains the same protein so that protein consumption is also the same.

The variance results showed that the five treatment rations containing 0%, 5%, 10%, 15%, and 20% of fermented shrimp waste had a significant effect (P<0.05) on body weight gain and final body weight achievement. The treatment that gave the highest body weight gain and final body weight achievement was the ration treatment with 5% and 10% fermented shrimp waste and had a significantly different effect (P<0.05) with the ration treatment containing 15% fermented shrimp waste. And rations containing 20% fermented shrimp waste, but not significantly different (P>0.05) with rations without the use of fermented shrimp waste (R0). The ration treatment with the addition of 20% fermented shrimp waste gave the lowest body weight gain. It was significantly different (P<0.05) with the ration without the use of fermented shrimp waste (R0), the ration containing 5% fermented shrimp waste (R1), and the ration containing 5% fermented shrimp waste (R1), including 10% fermented shrimp waste (R2). It can be seen that the treatment of using fermented shrimp waste up to a level of 10% in the ration did not decrease body weight gain, and a decrease began when the use of 15% fermented shrimp waste in the ration.

Not significantly different (P>0.05) ration treatment with the use of fermented shrimp waste 5% (R1) with ration treatment without the use of fermented shrimp waste (R0) and ration treatment using 10% fermented shrimp waste (R2) on the achievement of weight gain The body indicates that the balance of amino acids methionine and lysine in the ration treatment up to the level of use of 10% fermented shrimp waste is in the best balance in the ration, which is between 0.36:1 and 0.44:1 (Table 3) so that the ration treatment with the addition of fermented shrimp waste 5% (R1) and 10% (R2) can play an optimal role for growth and can meet the needs for the development of experimental local chickens. By the opinion [32], that the best balance of amino acids methionine and lysine in the ration with a protein content of 15% and metabolizable energy of 2,800 kcal/kg in local chickens aged eight weeks is between 0.3:1 and 0.4:1. It is also supported by opinion [2], that the best amino acid balance of methionine and lysine in chicken rations is in the balance between 0.39:1 and 0.44:1. According to [33], to meet protein needs as perfectly as possible, essential amino acids must be provided in the right amount and balanced in the ration to produce optimal body weight gain, especially in the balance of the amino acids methionine and lysine. Stated [34] that the amino acids methionine and lysine are indispensable for the growth of chickens. The results showed that the use of fermented shrimp waste up to 10% in the ration was able to supply amino acids according to the amino acid needs of the livestock to produce optimal body weight gain.

A good balance of amino acids and obtaining optimal body weight gain in treatment rations using 5% fermented shrimp waste (R1) and treatment rations using 10% fermented shrimp waste (R2) also illustrates an improvement in ration protein quality by using fermentation techniques on shrimp waste so that it affects the speed of body weight gain in local chickens, and the improvement in digestibility quality caused by the fermented shrimp waste flour used has optimal digestibility from the deproteination process treatment by the microorganism *Bacillus licheniformis* which produces chitinase enzymes and protease enzymes to degrade bonds. Glycosidic in chitin β (1,4) and liberates some protein in the form of N-Acetyl-D-glucosamine monomers and acetyl amino [35, 36]. *Lactobacillus* sp. serves as demineralization to break down glucose, sucrose, maltose, and lactose into lactic acid so that mineral deposits occur [37], and fermentation with *Saccharomyces cerevisiae* produces amylase, lipase, proteases, and other enzymes that can help the process of digestion of food substances in the digestive organs [38].

There was a significant difference (P<0.05) between the ration treatment with the addition of 15% fermented shrimp waste (R3) and the ration treatment with the addition of 20% fermented shrimp waste (R4), which was lower than the ration treatment with the addition of 5% fermented shrimp waste. (R1) and 10% (R2), this indicates an imbalance of amino acids in the treatment of R3 and R4 rations, causing a lot of protein waste. As a result, even though the protein content of the five treatment rations was relatively the same when viewed from the point of view of protein synthesis, the tissue cells would be different. This is because tissue protein synthesis is primarily determined by the completeness and level of amino acids that come or are transported into the tissue cells. By the opinion [39], that the synthesis process that takes place in the ribosome is highly dependent on the presence of amino acids that are needed and are picked up by DNA into the tissue. This causes the treatment ration with the addition of 15% (R3) and 20% (R4) fermented shrimp waste to produce lower body weight gain than the treatment ration with the addition of 5% (R1) and 10% (R2) fermented shrimp waste. It looks like that the treatment of rations with the use of fermented shrimp waste starting at a level of 15% there was a significant decrease in body weight gain.

The use of fermented shrimp wastes up to 20% in the ration gave the same sound effect as the ration treatment without fermented shrimp waste (R0) on the balance of protein efficiency. The study results [10] stated that the use of fermented shrimp waste up to 20% in the ration had the same effect as the ration without fermented shrimp waste. There was no significant effect (P>0.05) of the five ration treatments on the protein efficiency ratio, indicating that the ration treatment containing fermented shrimp waste up to 20% had the same good protein quality as the ration treatment without the use of fermented shrimp waste (R0). This proves that the fermentation process in shrimp waste with bacteria *Bacillus licheniformis*, *Lactobacillus* sp., and yeast in the form of *Saccharomyces cerevisiae* can improve the quality of ration protein by increasing the completeness and balance of essential amino acids contained in it and has optimal digestibility so that the protein in the waste fermented shrimp can be used as a substitute for protein from fish meal. The balance of methionine and lysine amino acids in the treatment ration with the user level of fermented shrimp waste 15% (R3 = 0.49:1) and 20% (R4 = 0.52:1) was still within the normal limits of the methionine and lysine amino acid balance (Table 3).

In line with the opinion [35], the amino acid balance of methionine and lysine between 0.48:1 and 0.52:1 in chicken rations is still within the normal range. This explains that the amino acid balance of the five treatment rations is still within normal limits so that the balance value of protein efficiency ratio resulting from the use of fermented shrimp waste up to 20% in the ration gives the same good results as the ration without the use of fermented shrimp waste (R0).

CONCLUSION

1. The use of fermented shrimp waste (by *Bacillus licheniformis*, *Lactobacillus* sp., and *Saccharomyces cerevisiae*) up to 10% in the ration formula, can replace fish meal, and improve growth performance and achieve the best final body weight in local chickens.
2. Shrimp waste from fermented products can be used up to a level of 20% in the ration formula without affecting the performance of local chickens.

REFERENCES

1. Abdel-Tawwab, M., Ahmad, M. H., Khattab, Y. A., & Shalaby, A. M. (2010). Effect of dietary protein level, initial body weight, and their interaction on the growth, feed utilization, and physiological alterations of Nile tilapia, Oreochromis niloticus (L.). *Aquaculture*, *298*(3-4), 267-274.
2. Soares, K. R., Lara, L. J. C., da Silva Martins, N. R., e Silva, R. R., Pereira, L. F. P., Cardeal, P. C., & Teixeira, M. D. P. F. (2020). Protein diets for growing broilers created under a thermoneutral environment or heat stress. *Animal Feed Science and Technology*, *259*, 114332.
3. Gehring, C. K., Davenport, M. P., & Jaczynski, J. (2009). Functional and nutritional quality of protein and lipid recovered from fish processing by-products and underutilized aquatic species using isoelectric solubilization/precipitation. *Current Nutrition & Food Science*, *5*(1), 17-39.
4. Reddy, V. R., Reddy, V. R., & Quddratullah, S. (1996). Squilla: A novel animal protein, can it be used as a complete subtitute for fish in poultry ration. *Feed Int*, *17*(3), 18-20.
5. Sawosz, E., Łukasiewicz, M., Łozicki, A., Sosnowska, M., Jaworski, S., Niemiec, J., ... & Chwalibog, A. (2018). Effect of copper nanoparticles on the mineral content of tissues and droppings, and growth of chickens. *Archives of animal nutrition*, *72*(5), 396-406.
6. Nolte, T., Jansen, S., Halle, I., Scholz, A. M., Simianer, H., Sharifi, A. R., & Weigend, S. (2020). Egg production and bone stability of local chicken breeds and their crosses fed with faba beans. *Animals*, *10*(9), 1480.
7. Fontes, T. V., de Oliveira, K. R. B., Gomes Almeida, I. L., Maria Orlando, T., Rodrigues, P. B., & Costa, D. V. D. (2019). Digestibility of insect meals for Nile tilapia fingerlings. *Animals*, *9*(4), 181.
8. WAHYUNTARI, B., & SETYAHADI, S. (2011). Process design of microbiological chitin extraction. *Microbiology Indonesia*, *5*(1), 7-7.
9. Chakravarty, J., Yang, C. L., Palmer, J., & Brigham, C. J. (2018). Chitin extraction from lobster shell waste using microbial culture-based methods. *Applied Food Biotechnology*, *5*(3), 141-154.
10. Mirzah, M., Fitrah, E., & Choirul, A. (2020, April). Effect of the Substitution the Fish Meal with Shrimp Head Waste Fermented in Diet on Broiler Performance. In *IOP Conference Series: Earth and Environmental Science* (Vol. 478, No. 1, p. 012076). IOP Publishing.
11. Yu, Y. H., Hsu, T. Y., Chen, W. J., Horng, Y. B., & Cheng, Y. H. (2020). The effect of Bacillus licheniformis-fermented products and postpartum dysgalactia syndrome on litter performance traits, milk composition, and fecal microbiota in sows. *Animals*, *10*(11), 2044.
12. Lin, K. H., & Yu, Y. H. (2020). Evaluation of Bacillus licheniformis-fermented feed additive as an antibiotic substitute: Effect on the growth performance, diarrhea incidence, and cecal microbiota in weaning piglets. *Animals*, *10*(9), 1649.
13. Saleh, A. A., Paray, B. A., & Dawood, M. A. (2020). Olive cake meal and Bacillus licheniformis impacted the growth performance, muscle fatty acid content, and health status of broiler chickens. *Animals*, *10*(4), 695.
14. Higgins, S. E., Higgins, J. P., Wolfenden, A. D., Henderson, S. N., Torres-Rodriguez, A., Tellez, G., & Hargis, B. (2008). Evaluation of a Lactobacillus-based probiotic culture for the reduction of Salmonella enteritidis in neonatal broiler chicks. *Poultry Science*, *87*(1), 27-31.
15. Mountzouris, K. C., Tsirtsikos, P., Kalamara, E., Nitsch, S., Schatzmayr, G., & Fegeros, K. (2007). Evaluation of the efficacy of a probiotic containing Lactobacillus, Bifidobacterium, Enterococcus, and Pediococcus strains in promoting broiler performance and modulating cecal microflora composition and metabolic activities. *Poultry science*, *86*(2), 309-317.
16. Ayad, A. A., Gad El-Rab, D. A., Ibrahim, S. A., & Williams, L. L. (2020). Nitrogen sources effect on Lactobacillus reuteri growth and performance cultivated in date palm (Phoenix dactylifera L.) by-products. *Fermentation*, *6*(3), 64.
17. Rao, M. S., & Stevens, W. F. (2005). Chitin production by Lactobacillus fermentation of shrimp biowaste in a drum reactor and its chemical conversion to chitosan. *Journal of Chemical Technology & Biotechnology: International Research in Process, Environmental & Clean Technology*, *80*(9), 1080-1087.
18. Shirazi, S. H., Rahman, S. R., & Rahman, M. M. (1998). Production of extracellular lipases by Saccharomyces cerevisiae. *World Journal of Microbiology and Biotechnology*, *14*(4), 595-597.

19. Pulvirenti, A., De Vero, L., Blaiotta, G., Sidari, R., Iosca, G., Gullo, M., & Caridi, A. (2020). Selection of wine Saccharomyces cerevisiae strains and their screening for the adsorption activity of pigments, phenolics and ochratoxin A. *Fermentation*, *6*(3), 80.
20. Ndegwa, J. M., Mead, R., Norrish, P., Kimani, C. W., & Wachira, A. M. (2001). The growth performance of indigenous Kenyan chickens fed diets containing different levels of protein during rearing. *Tropical animal health and production*, *33*(5), 441-448.
21. Yin, D., Selle, P. H., Moss, A. F., Wang, Y., Dong, X., Xiao, Z., ... & Yuan, J. (2019). Influence of starch sources and dietary protein levels on intestinal functionality and intestinal mucosal amino acids catabolism in broiler chickens. *Journal of animal science and biotechnology*, *10*(1), 1-15.
22. Skibniewska, K. A., Zakrzewski, J., Kłobukowski, J., Białowiąs, H., Mickowska, B., Guziur, J., ... & Szarek, J. (2013). Nutritional value of the protein of consumer carp Cyprinus carpio L. *Czech Journal of Food Sciences*, *31*(4), 313-317.
23. Brito, C. O., Junior, V. R., Del Vesco, A. P., de Castro Tavernari, F., Calderano, A. A., Silva, C. M., ... & de Azevedo, M. S. P. (2020). Metabolizable energy and nutrient digestibility of shrimp waste meal obtained from extractive fishing for broilers. *Animal Feed Science and Technology*, *263*, 114467.
24. Gernat, A. G. (2001). The effect of using different levels of shrimp meal in laying hen diets. *Poultry Science*, *80*(5), 633-636.
25. Abun, A., Saefulhadjar, D., Widjastuti, T., Haetami, K., & Wiradimadja, R. Energy-Protein-Consentrate as Product of Glucosamine Extract from Shrimp Waste on Performance Ofnative Chicken. *International Journal of Environment, Agriculture and Biotechnology*, *2*(3), 238801.
26. Haddar, A., Hmidet, N., Ghorbel-Bellaaj, O., Fakhfakh-Zouari, N., Sellami-Kamoun, A., & Nasri, M. (2011). Alkaline proteases produced by Bacillus licheniformis RP1 grown on shrimp wastes: application in chitin extraction, chicken feather-degradation and as a dehairing agent. *Biotechnology and Bioprocess Engineering*, *16*(4), 669-678.
27. Kaczmarek, S. A., Hejdysz, M., Kubiś, M., Nowaczewski, S., Mikuła, R., & Rutkowski, A. (2020). Effects of feeding intact, ground and/or pelleted rapeseed on nutrient digestibility and growth performance of broiler chickens. *Archives of animal nutrition*, *74*(3), 222-236.
28. Nascimento Filho, M. A., Pereira, R. T., Oliveira, A. B. S. D., Suckeveris, D., Burin Junior, A. M., Mastrangelo, T. D. A., ... & Menten, J. F. M. (2020). Cafeteria-Type Feeding of Chickens Indicates a Preference for Insect (Tenebrio molitor) Larvae Meal. *Animals*, *10*(4), 627.
29. Soomro, R. N., Abd El-Hack, M. E., Shah, S. S., Taha, A. E., Alagawany, M., Swelum, A. A., ... & Tufarelli, V. (2019). Impact of restricting feed and probiotic supplementation on growth performance, mortality and carcass traits of meat-type quails. *Animal science journal*, *90*(10), 1388-1395.
30. Widjastuti, T., Tanwiriah, W., & DARANA, S. (2015). Cihateup female ducks performance growth by various protein-energy rations given at water minim housing system. *Scientific Papers: Series D, Animal Science-The International Session of Scientific Communications of the Faculty of Animal Science*, *58*.
31. Sharma, N. K., Choct, M., Toghyani, M., Laurenson, Y. C., Girish, C. K., & Swick, R. A. (2018). Dietary energy, digestible lysine, and available phosphorus levels affect growth performance, carcass traits, and amino acid digestibility of broilers. *Poultry science*, *97*(4), 1189-1198.
32. Chang, S. K., & Zhang, Y. (2017). Protein analysis. In *Food analysis* (pp. 315-331). Springer, Cham.
33. Schiavone, A., Dabbou, S., Petracci, M., Zampiga, M., Sirri, F., Biasato, I., ... & Gasco, L. (2019). Black soldier fly defatted meal as a dietary protein source for broiler chickens: Effects on carcass traits, breast meat quality and safety. *Animal*, *13*(10), 2397-2405.
34. Brede, A., Wecke, C., & Liebert, F. (2018). Does the optimal dietary methionine to cysteine ratio in diets for growing chickens respond to high inclusion rates of insect meal from Hermetia illucens?. *Animals*, *8*(11), 187.
35. Ponce, L. E., & Gernat, A. G. (2002). The effect of using different levels of tilapia by-product meal in broiler diets. *Poultry science*, *81*(7), 1045-1049.
36. Bough, W. A., Shewfelt, A. L., & Salter, W. L. (1975). Use of chitosan for the reduction and recovery of solids in poultry processing waste effluents. *Poultry Science*, *54*(4), 992-1000.
37. Abun, T. W., & Haetami, K. (2016). Effect of Time Processing at Steps of Bioprocess Shrimp Waste by Three Microbes on Protein Digestibility and Metabolizable Energy Products of Native Chicken. *Agrolife Scientific Journal*, *1*(5), 209-2013.
38. Huezo, L., Shah, A., & Michel Jr, F. C. (2019). Effects of ultrasound on fermentation of glucose to ethanol by Saccharomyces cerevisiae. *Fermentation*, *5*(1), 16.
39. Benzertiha, A., Kierończyk, B., Rawski, M., Kołodziejski, P., Bryszak, M., & Józefiak, D. (2019). Insect oil as an alternative to palm oil and poultry fat in broiler chicken nutrition. *Animals*, *9*(3), 116.