Review Article/Derleme Makalesi 1(1): 33-41, 2022

Atatürk University
Faculty of Agriculture
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ATATÜRK ÜNİVERSİTESİ / ATATÜRK UNIVERSITY
PALANDÖKEN JOURNAL OF ANIMAL SCIENCE TECHNOLOGY AND ECONOMICS

The Effect of Some Selected Fruit Wastes for Poultry Feed on Growth Performance of Broilers

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Geliş Tarihi/Received	**Kabul Tarihi**/Accepted	**Yayın Tarihi**/Published
8.12.2021	1.01.2022	XX. XX.20XX

ABSTRACT: Increased consumption of animal products will lead to a large demand for animal feed. Given the scarcity of natural resources such as land and water, meeting this demand will be difficult. There are important environmental, economic and social factors that support the reuse of fruit processing by-products and the impact on growth performance in broiler feeding. Current research shows that fruit processing by-products can be used efficiently in broiler feeding. At the same time, such wastes causing environmental pollution will help to eliminate the environmental problems that arise. To include these unconventional feed sources in the diet of livestock, the level of rationing must be maintained. Fruit processing by-products are an outstanding source of nutrients that can potentially be used as animal feed after undergoing various processes to reduce the cost of animal feeding and ultimately increase farmers' profits. However, it is of great importance to evaluate the risks that may occur as a result of using these nutrients in animal diets. In this review, studies on the growth performance of some fruit wastes in broilers are discussed.

Keywords: Broiler, performance, fruit waste, leaf, pomace

Kanatlı Yemi İçin Seçilmiş Bazı Meyve Atıklarının Etlik Piliçlerin Büyüme Performansına Etkisi

ÖZET: Artan hayvansal ürün tüketimi, büyük bir hayvan yemi talebine yol açacaktır. Toprak ve su gibi doğal kaynakların kıtlığı göz önüne alındığında, bu talebi karşılamak zor olacaktır. Etlik piliç beslemede meyve işleme yan ürünlerinin yeniden kullanımını ve büyüme performansının etkisini destekleyen önemli çevresel, ekonomik ve sosyal faktörler vardır. Mevcut araştırmalar, meyve işleme yan ürünlerinin, etlik piliç beslemede verimli bir şekilde kullanılabileceğini göstermektedir. İşlendikten sonra açığa çıkan bu atıklar aynı zamanda çevre kirliliğine de neden olmaktadır. Bu nedenle bu tür atıkların hayvan beslemede kullanılması ortaya çıkan bu çevre kirliliğinin giderilmesine de katkı sağlayacaktır. Bu geleneksel olmayan yem kaynaklarının çiftlik hayvanlarının diyetine dahil edilmesi için rasyona katılım seviyesi (oranı) iyi belirlenmeli ve bu oran korunmalıdır. Meyve işleme yan ürünleri, hayvan besleme maliyetini azaltmak ve sonuç olarak çiftçilerin karlarını artırmak için çeşitli işlemlerden geçirildikten sonra potansiyel olarak hayvan yemi olarak kullanılabilecek olağanüstü bir besin kaynağıdır. Bununla beraber bu besinlerin, hayvan diyetlerinde kullanılması sonucu oluşabilecek risklerinde değerlendirilmesi büyük önem arz etmektedir. Bu derlemede, bazı meyve atıklarının etlik piliçlerde büyüme performansı üzerine yürütülen çalışmalar irdelenmiştir.

Anahtar Kelimeler: Etlik piliç, performans, meyve atığı, yaprak, prina

Atıf için / To cite
Yeniçeri M, Filik AG, Filik G, 2022. The Effect of Some Selected Fruit Wastes for Poultry Feed on Growth Performance of Broilers. Palandöken Journal of Animal Science, Technology and Economics, 1(1): 33-41.

INTRODUCTION

Rapidly developing poultry farming significantly increases feed consumption and feed costs. As it is known, feed costs constitute a large part (about 70%) of the production costs in the poultry industry. For this reason, various researches are carried out in order to meet the increasing feed requirements and reduce the feed cost. One of the important issues emphasized in these studies is to investigate the potential of alternative feed sources to be used in poultry nutrition. The use of nutrients that can be consumed as human food in animal nutrition is not recommended because it creates consumption competition between humans and animals. However, some fruits that remain as waste after human consumption have a relatively more suitable feed potential for animals and can be used as a feed source. Especially after the juice of the fruits is used in the fruit juice industry, the remaining pulp cannot be offered for human consumption. It is possible to evaluate the pulps in question by adding them to poultry feeds in an appropriate way. Thus, it is thought that it will contribute to the reduction of feed costs by both reducing the amount of waste released to nature and evaluating the wastes that have no economic value. Studies have reported that much fruit waste has positive effects on the nutritional values and performance of poultry. In these studies, when various fruit waste mixtures such as olives, apples, bananas, carrots, citrus, melons, and tomatoes were added to the rations of broiler chickens, it reduced feed efficiency and abdominal fat ratio, and when fruit skins with high natural antioxidant content were used as feed additives in broiler chickens' diet, a growth rate was observed. It has been reported that it has a positive effect on microbial and immunological parameters (Rizal et al., 2010; Faiz et al., 2017).

In this review, the effects of various fruit wastes on the growth performance of broiler chickens are discussed.

USE of APPLE WASTE in POULTRY NUTRITION

Apple production has increased significantly worldwide in recent years. A significant portion of fresh apples is used to produce juices, flavors, and concentrates (Lu et al., 2016). During the production of these products, a relatively large amount of solid residue is used in poultry diets, which does not have the properties necessary for human nutrition, is high in nutritional value, and is easily consumed, mainly consisting of shell, seed, or pulp (Villas-Bôaset et al., 2003).

Apple peel

Heidarisafar et al. (2016) examined the effects of apple peel (0, 5, and 10% diet) on the performance of broiler chickens under heat stress conditions. The addition of 10% apple peel in diets increased the weight of the gizzard and small intestine of chickens. Dietary treatments with 5 and 10% apple peel waste increased lipids and HDL and decreased LDL and malondialdehyde in blood serum. However, apparent ileal protein digestibility in chickens fed diets containing 5 and 10% apple peel waste was reduced. Nobakht (2013) recommends that the presence of potassium in apple waste assists electrolytic equilibrium increasing the digestibility and absorption of nutrients and, in general, improving the growth traits and health status of poultry.

Apple seed

Azor Anongu et al. (2017) examined the effect of feeding graded levels (0, 5, 10, 15, 20, 25 and 30%) of untreated African star apple kernel meal (ASAKM) on the performance and blood profile of broilers in an 8-week trial and the results showed that the kernel was high in nutrients, especially carbohydrates as a source of energy, but contained high levels of anti-nutritional or toxic factors. Performance traits (P<0.05) of broilers fed ASAKM gave poor results, though without mortality.

Apple pomace

Nobakht (2013) used apple pomace (0, 2.5, 5, and 7.5%) in the diet of laying hens and showed that hens fed 5% apple pomace performed best and had the highest lymphocyte levels. However, all treatments resulted in a negative impact on egg quality. Aghili et al (2019) have reported that administration of 12, 16, and 20% dried apple pomace deteriorated the growth performance of broilers, and carcass characteristics and internal organs of broilers at 42 days of age did not show any specific trend between treatments.

Overall results indicated that in native laying hens, using apple pulp up to 10% of diets, and 0.05% of multi-enzyme (Saphyzim) did not have any adverse effects on their performance and blood parameters; however, apple pulp at a level of 15% showed adverse effects in these respects and is not recommended by Ghaemi et al (2014). Djunaidi et al. (2021) reported that up to 15% apple pulp meal can be substituted for maize in chicken feed without affecting broiler production and internal performance. Also in this study, it is recommended to replace maize with apple residues processed using glucanase enzyme from 7 days old to make sure the first growth of chickens is still good and normal.

USE of BANANA WASTE in POULTRY NUTRITION

With over 7 million tons of bananas produced each year, the banana is one of the most produced plants in the world. About 30−40% of the total banana production is rejected for failing to meet quality standards and is potentially available for feeding to broilers. Banana leaves contain 8% polyphenols, but very few condensed tannins. Banana peel constitutes about 30% of fresh banana by weight, and banana leaf has been reported to constitute 85% water and 10-17% protein on a dry matter basis. Banana fruit contains about 1 gram of protein, 28 g of carbohydrates, 2.8 g of fiber, 0.6 g of fat, 467 mg of sodium, 1 mg of potassium, and 9.2 mg of calcium. Furthermore, the nutrient composition of its fruit is broadly similar to that of the banana peel (Hang et al., 2018; Dumorné et al., 2020).

Banana leaves

Abel et al. (2015) reported that in a 4-week study of broiler chicken rations by adding 10, 20 and 30% banana peel as a substitute to corn, there were statistically significant differences between the control group and the group containing 10% banana peel in terms of daily live weight gain, daily feed consumption and slaughter weight. Significant differences were found for the same parameters in the groups containing 20% and 30% banana peel. The researcher reported that 10% of the banana peel addition to the finishing rations did not cause any adverse effects on broiler chickens.

Haryanto et al. (2016) have reported that FCR (Feed conversion ratio), total cholesterol, and LDL levels were not significantly different ($P>0.05$) after administration of banana peel meal, while HDL and triglyceride levels were significantly different ($P<0.05$) among the treatment groups. Researchers recommend banana peel meal be used as an alternative nutrient material in commercial broiler chicken feed to reduce the cost of production. In another study investigating the use of banana peel with or without enzyme as a substitute for corn in broiler rations, rations containing 15, 30, and 45% banana peel were prepared and fed for 42 days. According to the results of the study, the addition of banana peel to the ration did not have a negative effect on the performance of broiler chickens, while the addition of enzyme provided only a numerical improvement.

Compared to the control group, blood cholesterol and triglyceride levels were found to be lower in the groups containing banana peel (Blandon et al., 2015).

Banana leaf

Silva et al (2019) reported that there was no significant influence ($P>0.05$) on productive performance with banana leaf in natura in the diet. Furthermore, have shown the daily addition of banana leaf did not influence ($P<0.05$) FI (feed intake), EP (egg production), EM (egg mass), FCEM (feed conversion per egg mass), FC12E (Feed conversion per dozen eggs), EW (the mean egg weight), YW (yolk weight), BW (shell weight in grams), AW (albumen weight in grams), YP (yolk pigmentation), Y% (yolk percentage), A% (albumen percentage) and B% (shell percentage).

In the study, the addition of banana leaves to the diets of broilers significantly affected the final body weight, daily feed intake, daily live weight gain, and feed conversion ratio ($P<0.05$). Although the groups treated with banana leaf outperformed the control group and the mean final body weight, daily body weight gain, and feed conversion ratio for the birds were similar ($P>0.05$), the groups fed with banana leaf powder and banana leaf extract were similar. It has been reported that birds fed with banana leaf extract have a numerically heavier final body weight and daily weight gain (5.03%) compared to birds fed with banana leaf extract. Banana leaf powder consumed an insignificantly ($P>0.05$) less amount of feed compared to control and banana leaf extract, with a difference of approximately 5.00% and 6.80%, respectively. This translated into a better feed conversion rate of 2.61 (Okoleh et al., 2015).

In the study conducted with 180 3 week old Hubbard chicks, each group was given unfermented and fermented for 5, 10 and 15 days (factor A), respectively, and 5, 10 and 15% banana leaf pulp (factor B). Daily feed intake was significantly ($P<0.01$) affected by brood and banana leaf levels, and daily feed intake values were highest at the 10% treatment level incubated for 10 days (125.10 g/day). Daily weight gain was significantly affected ($P<0.01$) by diet and incubation, and daily weight gain values were highest at the 10% treatment level incubated for 10 days (58.03 g/d). Feed efficiency was significantly affected ($P<0.01$) by hatching and banana leaf, and feed efficiency values were highest at the 10% treatment level incubated for 10 days (0.46). The high feed intake in A10B10 may be due to the fact that adding 10% of banana leaves fermented for 10 days can affect the flavor of the feed. This result indicated that the addition of 10% banana peel powder to conventional feed significantly improved growth performance compared to control, and the productivity of birds fed 10% banana leaves

fermented for 10 days may result from better digestion and feed utilization following stimulation of digestive enzymes by these treatments (Mandey et al., 2015).

USE of CITRUS WASTE in POULTRY NUTRITION

In the food industry, after citrus fruit processing, citrus peel is obtained as waste. In this way, significant amounts of citrus peels are obtained each year in fruit industries throughout the world (Karabayır et al., 2018). The edible part, which constitutes approximately 52% of the pomegranate fruit, is consumed, processed, and evaluated, and the remaining part is largely discarded (Zarei et al., 2011).

Citrus peel

The peel and pulp of citrus fruits, which are consumed as fresh and processed in the industry, are waste products that have important potential in terms of animal nutrition. Orange peel contains 86.2-87.4% dry matter, 5.6-7.4% crude protein, 3-8.19% ash, 13.5-20% crude fiber and 1354-3674 kcal/kg. The lemon peel contains 9.2% crude protein, 17.5% fiber, 6.1% ash, 0.1% total phosphorus, and 1.06% calcium. For this reason, the effects of citrus peel and pulp processed by different methods were investigated by adding various levels to poultry rations (Basir and Toghyani, 2017).

In the study the researchers examined in an 8-week study investigating the possibilities of using orange peel as a substitute for corn in broiler rations, the fattening performance and blood parameters were measured by adding 0, 2.5, 5, 7.5, and 10 percent orange peel powder to the rations. While there was no difference between the groups in terms of daily feed consumption and mortality rate, the values of slaughter weight and daily body weight gain of the treatment groups were lower than those of the control group. In terms of daily feed consumption, the groups containing 2.5% and 5% orange peel gave similar results to the control group, while the other groups gave lower values than the control group. It has been reported by the researchers that the differences between the groups in terms of hemoglobin in the blood, the volume of erythrocytes, and the total number of erythrocytes are insignificant (Ojabo and Adenkola, 2013).

In the another study, in a 6-week study examining the effects of adding orange peel (0, 2.5, 5, 7.5, 10%) to broiler diets on growth characteristics and blood oxidant levels, the values obtained in terms of slaughter weight and feed consumption were lower in the treatment groups compared to the control group. found. There was no significant difference between the groups in terms of feed efficiency level. The blood antioxidant level increased depending on the ratio of orange peel in the ration, and it was measured in the group containing the highest 10% orange peel (Faiz et al., 2017).

In a 42-day study in which 0.5 and 10% citrus peel and pectinase were added to broiler diets, it was reported that the fattening performance was adversely affected due to the increase in the ratio of citrus peel in the diet, and the pectinase enzyme did not affect the measured parameters (Dehghani et al., 2016).

In a study conducted by adding different levels of orange peel (5, 10, and 15%) to broiler finishing rations, slaughter weight, daily live weight gain, and daily and total feed consumption values were found to be lower in the treatment groups compared to the control group. The feed conversion rates of the groups containing orange peel up to 10% and the control group were found to be similar. In terms of daily protein intake, it has been reported that the group containing 5% orange peel and the control group showed similar results (Ani et al., 2015).

Citrus pulp

Researchers reported citrus pulp could be used as recycled industrial feed in animal nutrition by drying with a scrubber heat source dryer (Filik and Kutlu, 2018).

The growth performance of Ross 308 broilers fed with different levels of CSP during the initial period (days 1–21 postpartum), the ending period (days 22–35 postpartum), and the total period (1–35 postpartum days) was assessed. There was no difference in broiler feed intake, weight gain, and feed conversion rate at baseline and total period compared with control groups. However, significant differences in performance parameters were observed during the end period, and the groups fed a diet supplemented with 1.0% and 2.0% DCSP (dried sweet orange (*Citrus sinensis* pulp) improved significantly compared to control groups. Feed intake (i.e., feed consumption) and feed conversion ratio were better than in the control group (P=0.04 and P=0.07). During the finishing period, broiler weight gains in each group gradually increased as expected (P=0.04). In contrast, the addition of up to 1.0% DCSP to the mixes resulted in lower feed intake and weight gain and an unbalanced feed conversion ratio in the initial period, reflecting a tendency to decrease in growth and unproductive situations with a very low feed conversion rate. In addition, better daily body

weight gain over the entire growth period was associated with treatments containing gradually increasing DCSP content (e.g., 2.0% DCSP) over the total period, with the lowest gain reported in chickens fed 2.0% (Abbasi et al., 2014).

In the study, a total of 966 Cobb male broiler chicks were fed six levels of dietary citrus pulp (0, 2, 4, 6, 8, and 10%) increasing with seven replicates of 23 birds each. The inclusion of citrus pulp in the diet of 1 to 21 day old chickens did not significantly affect organ weight and gut morphology ($P>0.05$). However, researchers reported that citrus pulp can be used up to 10% in rations for broilers aged 1 to 42 days without impairing broiler performance, carcass yield, gut morphometry, and meat quality (Diaz-Vargas et al., 2018).

In a study conducted to investigate the effect of adding citrus pulp (5% or 10%) or dried pasture (5% or 10%) on the performance, carcass yield, and characteristics of broilers, the results of the growth performance were found to be 26% of the daily weight gain in birds treated with 10% citrus pulp. showed a decrease in rate ($P<0.05$). Birds consuming diets containing 5% or 10% citrus pulp have been reported to experience increases in feed intake compared to control treatment, resulting in significantly higher feed conversion rates at the 10% level (Mourão et al., 2008).

USE of GRAPE WASTE in POULTRY NUTRITION

Grapes are mainly used for wine production. Winery waste and by-products as percent of grapes include grape stalks (2.5−7.5 percent), grape pomace (~15 percent dry; wet up to 25−45 percent) and grape seeds (3−6 percent) and yeast lees (3.5−8.5 percent) [yeast lees are the residual yeast and other particles that precipitate at the bottom of a wine vat]. Grape pomace contains up to 15% sugar, 0.9% phenolics or pigments (red grape pomace), 0.05–0.08% tartarate, and 30–40% fiber. Grape seeds contain 4−6 percent phenolics and 12−17 percent oil, very rich in linoleic acid-omega-6 fatty acid (76 percent). The yeast lees contain 0.012 percent pigments, 0.1−0.15 percent tartrate and 6−12 percent β 1, 3-glucans. The utilization of grapes in broiler diets could use up 6% without significant effect on growth performance. Also, economically, grape pomace is a good alternative to corn and soybeans (Garavaglia et al., 2016; Perra et al. 2021).

Grape pomace

In the study 96 feathered 80-week-old Bovans laying hens were used to determine the effects of adding raisin pulp to a corn-soybean based diet on performance, egg quality, plasma and egg lipid peroxidation, and some biochemical parameters of laying hens. Chickens were fed a diet supplemented with 0% (control), 4%, and 6% grape pomace (experimental groups) for 12 weeks. It was reported that the addition of grape pomace to the laying hen diet did not significantly affect body weight, feed intake, egg production, or feed yield ($P>0.05$) (Kara et al., 2018).

In the study, the live weights of broiler chickens fed with grape pomace increased slightly compared to the control group, but no significant difference was found. In the study conducted with 250 mg, 350 mg and 450 mg values, it was reported that the highest body weight was found in broiler chickens fed with 450 mg kg^{-1} grape pomace in the diet (2257.75±20.11 g) (Dupak et al., 2021).

The experiment was conducted to investigate the efficacy of grape pomace (*Vitis vinifera*) on growth performance, apparent total system digestibility of nutrients, blood profile and meat quality in commercial broilers. In the study conducted with four hundred chickens (3 days old), 4 diet applications for 28 days, diet applications 1) control, 2) 5 gr/kg grape pulp, 3) 7.5 gr/kg grape pulp, and 4) after drying, they were added to the rations. It has been reported that grape pomace supplementation did not show linear effects ($P>0.05$) on body weight gain, but second-line effects ($P<0.05$) on body weight gain were observed from days 0 to 7 and 8 to 14. Overall, secondary effects of grape pomace supplementation on body weight gain during early growth stages have been reported (Aditya et al., 2018).

Grape seed

Viveros et al. (2011) reported use of grape seed in broiler chicken diets control 553 g, grape seed 486 g, the broiler chicken's weight not affected.

In another experiment, diets included a control diet (without additives) and three levels of grape seed powder (10, 20 and 40 g/kg of diet). Each diet was fed to a total of 300 one- day-old Cobb- 500 chicks for 42 days. The addition of 20 g/kg of grape seed to the basal diet increased final body weight and body weight gain, improved the feed conversion ratio, and did not affect feed intake (Abu Hafsa and İbrahim, 2018)

In another study with a total of 432 chicks; In the comparison of the control group and the five experimental groups (10 gr/kg grape pomace, 20 gr/kg grape pomace, 5 gr/kg grape seed, 10 gr/kg grape seed and 15mL/L grape pomace polyphenolic extract), researchers 5 gr/kg reported a large

increase in the growth rate of chicks in the grape seed group. Researchers reported a greater increase in growth rate from the first week of life of the chicks throughout their growth in the 5 g/kg GS group, with the average body weight of the chicks significantly higher (P<0.01) than the CON (control) (Pascariu et al., 2017).

USE of OLIVE WASTE in POULTRY NUTRITION

Olives are used for their useful fatty and fatty acid content for humans. Because of this content, olive waste is used as animal feed. Olive contain several antioxidants that can potentially scavenge free radicals and provide antioxidant protection. Olive waste reduces the need to use alternative low-cost feedstuffs in order to reduce feeding costs (King et al., 2014; Gerasopoulos et al., 2015).

Olive leaves

In the study, it was reported that olive leaf significantly reduced body weight gain in all experimental periods (0>30=50, 0=15>50) (P<0.05) (Shafey et al., 2013).

In another study, in which the researchers examined, the feeding experiment, 120 Ross 308 broiler chickens were used, 21 days old chickens were fed with 5% or 10% olive leaf ration and no additives the end of the feeding experiment (42 days), 12 chickens were randomly selected from each group and slaughtered. Bone samples (femur, tibia and humerus) were taken from each chicken at the slaughter line. The addition of olive leaf and cake did not have a significant effect on the growth performance and mineral content of the femur, tibia and humerus of broiler chickens. Addition of 5% and 10% olive leaves to the feed resulted in higher Cu content in the humerus, but bone mineralization was not changed. In conclusion, this study demonstrated olive leaf not alter bone mineralization but can be added to feed mixes for broilers without adverse effects on growth performance (Pečjak et al., 2020).

Agah et al. (2019), 200 Ross 308 broilers were used for growth performance. In this study, negative control and positive control of 250 mg and olive leaf of 200 or 400 mg were used in the diets of broilers. As a result, it was reported that no difference was observed in body weight gain (BWG), feed intake (FI), and feed conversion ratio (FCR) in male chickens fed different diets in this experiment.

Olive pomace

In the study, the researchers reported that the bioactive pomace extract obtained from 750 ppm Olea europaea given to the diets of 306 1-day-old chickens improved animal growth as a result of its anti-inflammatory properties (Herrero-Encinas et al., 2020).

In the study, researchers found the effect of treatment on body weight to be significant only on the 28th and 35th days. In the experiment, the addition of 5 g/kg olive leaf to the mixed feed provided higher body weight than the control group on the specified days. The effect of the treatment on live weight gain and feed consumption was significant only between 21-28 days, and the live weight gain in this period was in the treatment group fed with 5 g/kg olive leaf added feed, while feed consumption was 5 g/kg and 20 g/kg olive leaf added. It was reported by the researcher that it was significantly higher in the treatment groups fed with the feeds compared to the control (Yavaş, 2013).

In another study conducted by the researchers, there was no difference between the control group (body weight 844,64), 5% OP (Olive pulp) and 10% OP groups in terms of live weight gain and feed consumption in the initial period (Day 0-21), while the group treatment containing 15% OP (body weight 768,11) was compared with the live weight control group. Tüzün and Ünlü, (2016) reported a linearly lower body weight gain (76.53 g) (P<0.05).

CONCLUSION

Today, while the cost of poultry rations is increasing, animals are in competition with humans for food. Therefore, some waste parts of fruits that are not consumed by humans are recommended to be used as an alternative source of feed additives in poultry rations after appropriate processing methods are applied. Since fruit by-products can be added to broiler rations without affecting their flavor, digestibility, nutrient content, health, or performance, and since effective and efficient use of these by-products will reduce the cost of feed, it will be a profitable situation for businesses. It is concluded that the inclusion of these wastes as feed components in poultry rations using appropriate processing methods will help reduce the overall poultry production cost and environmental pollution, and will contribute positively to the growth performance of broilers. Fruit by-products can be fed as livestock feed without effecting the palatability, digestibility, nutrient content, health or performance. After observing different research works or findings from books or journals, both beneficiary and harmful effects are found due to addition of fruit by-products to livestock diets. The effective and efficient utilization of fruit by-products will reduce the feed

cost and the farmer will be profitable. Nowadays, the cost of poultry ration is alarmingly increasing, and birds are competing with human for food. Therefore, after following the procedures of appropriate processing methods of fruit waste, it should be used as a source of alternative feed ingredient in poultry rations. Heating, cooking, steaming, and sun drying are among the methods used for the drying of such wastes. Based on this review it can be recommended that by using appropriate processing method, incorporating these wastes as feed ingredients in poultry rations according to the recommended inclusion level helps to reduce the overall poultry production cost and environmental pollution.

Conflicts of interest

The authors do not declare any conflicts of interest.

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