Research Article

Impact of Usage of Fruit Waste on Growth Performance, Carcass Characteristics, Organs Weight and Blood Chemistry in Broilers

Muhammad Shahid Nisar[1*], Ahmad Kamran Khan[1], Ghulam Fatima[2], Irfan Ahmed[4], Khizar Sami Ullah[2] and Syeda Amber Hameed[2,5]

[1]Department of Plant Protection, Faculty of Agriculture, Ghazi University, Dera Ghazi Khan, Punjab, Pakistan. [2]Department of Zoology, Wild Life and Fisheries, Faculty of Sciences, Ghazi University, Dera Ghazi Khan, Punjab, Pakistan. [3]Department of Animal Nutrition, Faculty of Veterinary and Animal Sciences, The Islamia University of Bahawalpur, Bahawalpur, Pakistan; [4]Department of Microbiology, Ghazi National Institute of Engineering and Sciences, Dera Ghazi Khan, Punjab, Pakistan.

Abstract | A total 240 1-day-old straight-run (Ross-308) broilers were used to investigate the effect of fruit waste (FW) on live performance and blood parameters of Broilers for 56 days. Four experimental diets comprising 3 replicates with 20 birds each were tested with using complete randomized method consisting Diet 1 (D1) (treatment 1) with 100% basal feed (BF) and 0% fruit waste (FW), diet 2 (D2) (75 BF + 25% FW), diet 3 (D3) (50% BF + 50% FW) and diet 4 (D4) (25% BF + 75% FW). Non-significant results (p>0.05) were found in feed intake and body weight gain and carcass characteristics in all treatment groups while feed conversion ratio (FCR) were resulted significantly difference (p<0.05) in D2 (1st, 3rd, 4th, 5th week), D3 (1st and 3rd week) and D4 (1st, 2nd, 4th and 5th week). In case of organs weight except gizzard, all other organs (liver, heart, intestine, pancreas, lungs, spleen and kidney) resulted significantly difference (p<0.05) and affected with FW supplementation. Broiler fed with 25% and 50% FW affected positively (p<0.05) to lymphocytes, granulocytes, red blood cells, hemoglobin, mean corpuscular hemoglobin and mean platelet volume while D3 also resulted positively in results of mid-range absolute count. While birds fed D4 (75% FW) resulted significant difference (p<0.05) in mean platelet volume. Overall, D2 and D3 that offered with 25% and 50% FW replacement showed better results than the control treatments with basal feed. It is suggested that as a supplements, FW can be added in feed as medicinal effects of fruit wastes by reducing the antibiotic usage in broilers and decreased the environmental pollution and for functional food ingredients, natural antioxidants, antimicrobial compounds and substantially reduce the amount of waste.

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***Correspondence** | Muhammad Shahid Nisar, Department of Plant Protection, Faculty of Agriculture, Ghazi University, Dera Ghazi Khan, Punjab, Pakistan; **Email:** mnisar@gudgk.edu.pk, akamran@gudgk.edu.pk
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Introduction

Increase in human population, high demand of food and nutritional importance leads to an increase in high poultry production in a very small period of time with the use of growth promoting hormone and antibiotics (Chattopadhyay, 2014). Antibiotic is a substance that inhibits the growth of a microorganism. Metronidazole, vancomycin, chloramphenicol, and tetracycline are effective antibiotics used in poultry for anti-microbial or antifungal activities also used for high yield of meat in broilers (Mehdi *et al.*, 2018). Curative and sub-therapeutic uses of antimicrobials for animals are of increasing interest regarding the disclosure and distribution of resistant zoonotic bacterial pathogens (Economou and Gousia, 2015). A serious threat emerges due to antibiotic resistance with global deaths estimated by 2050 to reach 10 million people every year, but it is challenging to quantify the associated excess morbidity and mortality (de Kraker *et al.*, 2016; Ahmed *et al.*, 2022). Thus, due to the emergence of microbes resistant to antibiotics which are used to treat human and animal infections, the European Commission (EC) decided to phase out, and ultimately ban (January 1st 2006), the marketing and use of antibiotics as growth promoters in feed (EC Regulation No. 1831/2003) (Huyghebaert *et al.*, 2011). Antimicrobial drugs are used indiscriminately likely to hasten the development of antibiotics resistance in pathogens (Aalipour *et al.*, 2013). To cope up these problems, poultry management emphasizes the use of natural resources which are inexpensive and have no hazardous effects on human health (Hossain *et al.*, 2013). Fruit crops are used as natural anti-oxidant as a rich source of nutrient which produce meat juicy, tenderness and sweet in taste. To meet this requirement will be a problem for human that will reduce the sources of food as well water. Every year around 1.3 billion tons of food is vanished and wasted in which fruits and vegetables are the major part of this cost (Åhnberg and Astrid, 2010). Currently, their disposals pose an environmental health risk due to their high volume and moisture content, thus becoming a suitable substrate for obnoxious microbes to thrive (O'Shea *et al.*, 2015). Fruits remaining have an important role in food industry that can be used as a food additive (antioxidants, antimicrobials, colorants, flavorings, and thickener agents. Fruit peels, pomace and unused parts are a good source of natural anti-oxidant (Gowe, 2015). The usage of fruit left-over as animal feed will place back in the human food chain, reduce the environmental pollution. The fruits waste which can be used including apple, banana, oranges, grapes, lemons and strawberry as healthy farm animals feed (Schlegel, 2003).

Use of fruit waste in poultry could be very cost effective method to mix in poultry feed at very low price by having beneficial effects or positive growth rate in poultry. For the above mentioned multiple beneficial effects of fruit peels, the study was aimed to use fruits waste in the poultry feed to reduce the utilization of the antibiotics in feed.

Materials and Methods

The experiment was conducted in the Government Poultry Farm, Dera Ghazi khan, Punjab, Pakistan.

Fruits collection and preparation of feed

Fruit waste (FW) including ripened banana, orange and apple peels was collected at the popular local fruit juice shops dried under the sun, grinded dried pieces into granules form and mixed with basal diet in equal proportions to offer the chicks. Basal diet refers to the diet that provides energy and protein with basal nutrients in quantities to meet basic body needs.

Ethical statement on experimentation of animals

The rearing, culling and sampling of the birds were followed by the principles of Animal Ethical Committee of Ghazi University, Dera Ghazi Khan. The Guidance was followed for the animal care and use according to the National Research Council, USA (NRC, 2011).

Experimental birds, housing and management

A total of 240 birds, d-old mixed-sex Ross-308 were bought from local commercial hatchery and randomly divided into twelve floor pens with 20 birds in each pen. Rice hulls were used as litter material. Vaccination was followed according to the schedule. Water and feed were provided *ad-libitum* throughout the experiment. The standard temperature, ventilation and light management was done during the experiment. Broiler growth and performance depend on the expose time of the light provided for maximum biological functions. The data was recorded daily basis from slaughtering birds and their weights were recorded for feed conversion ratio (FCR) calculations. Three standard basal diets were manufactured from well-reputed feed mill with started (1-7 d), grower (8 to

21 d), finisher (22 to till end of experiment) (Table 1). In current study, four treatments were used and each treatment has three replicates. D1 (control) was given BF100% + 0% FW, chicken in D2 were offered with (BF 75%+25% FW), D3 were offered with (50% BF+50% FW) and, chickens in D4 (25% BF + 75% FS).

Study parameters

Feed intake was calculated on daily basis while body weight gain (BWG) and feed conversion ratio (FCR) were calculated on weekly basis. Mortality rate was calculated on daily basis. After 56 days, five birds from each treatment were selected and weighed and then slaughter by cervical dislocation. Vital organs (Gizzards, liver, heart, small intestine, pancreas, lungs, spleen and kidney) and dressing percentage, breast and thigh weights were calculated at the end of experiment. For blood analysis, 5 ml blood was collected from the wings of five birds per treatment with addition of anticoagulant. The concentration of white blood, lymphocytes, mid-range absolute count, granulocytes, red blood cells, hemoglobin, mean corpuscular hemoglobin concentration, mean corpuscular hemoglobin, mean corpuscular volume, mean platelet volume were calculated by complete blood count.

Table 1: *Nutrients composition.*

Nutrients (%)	Starter (1 to 7 d)	Grower (8 to 21 d)	Finisher (22 to 35 d)
Metabolisable energy (Kcal/kg)	2850	2900	2950
Crude protein	22	21	20
Crude fiber	3.80	3.75	3.84
Ether extract	4.02	4.22	4.80
Ash	5.01	4.94	4.73
Calcium	0.81	0.78	0.75
Available phosphorus	0.42	0.40	0.39
Lysine	1.19	1.16	1.08
Methionine	0.51	0.49	0.47
Threonine	0.73	0.69	0.67

[2]Supplied per kilogram of diet: vitamin A, 15,000 IU; vitamin D3, 3300 IU; vitamin E, 62.5 mg; vitamin K, 3.6 mg; vitamin B1, 3 mg; vitamin B2, 9 mg; vitamin B6, 6 mg; vitamin B12, 0.03 mg; niacin, 60 mg; calcium pantothenate, 18 mg; folic acid, 1.5 mg; biotin, 0.36 mg; choline chloride, 600 mg; Fe, 80 mg; Cu, 12 mg; Zn, 75 mg; Mn, 60 mg; I, 0.35 mg; Se, 0.15 mg; growth promoting agent, 30 mg; and antioxidant, 100 mg.

Statistical analysis

The collected data were analyzed by using analysis of variance (ANOVA) under complete randomized block design and SAS 9.1 version (SAS, 2001) was utilized. Statistical significance was set at $p<0.05$. Data for all parameters were exhibited as mean ± SEM. There are non-significant differences with same numbers on mean value.

Results and Discussion

Production parameters

The results of current study show that different concentration of fruits peel like apple, banana and citrus differed significantly among all the treatments. Production paramters include that affected by feeding to the chicken including feed intake, weight gain and feed conversion ratio. In current study, higher Feed intake was shown significant difference ($p<0.01$) in D3 treatment supplemented with 50% of FW as compared to the other treatment groups while lower feed intake was found in D4 that may be due to refusal of feed due to taste and fiber contents of peels as presented in Table 2 at 35th d. In the current study, the assessment with the control treatment of broiler chicks, detected significant differences ($p<0.01$) in the FCR, BWG and blood metabolites but carcass components showed non-significant differences ($p>0.01$) results among groups. Similarly, to our results, Herrero-Encinas *et al.* (2020) reported the improvement of average daily gain and FCR in broiler chickens during the grower-finisher period by supplementation of the 750 mg/kg olive-pomace extract (Herrero-Encinas *et al.*, 2020). While Bostami *et al.* (2015) described the inclusion of the 20 g/kg dietary level of pomegranate waste in broiler chicken diet improved the body weight gain (Bostani *et al.*, 2015). Bioactive substances present in the fruit waste have the capacity to enhance the feed efficiency by improving, bile acid function, and decreasing the intestinal viscosity and nutrient digestibility (Colombino *et al.*, 2020). Similar results were reported by Ebrahimi *et al.* (2013) that carcass yields were higher in the chicken fed diets with 15 g/kg of dried orange peel waste as compared to the control group (Ebrahimi *et al.*, 2013). Feed with concentration of 25 percent fruit waste and 50 percent fruit waste showed better results than the control treatments with basal diets. During the whole experiment BWG and FI were increased gradually as increase in fruit peels waste concentration among the treatments groups but the FCR decreased as BWG and FI increase (Tables 3, 4). Similar results were described by Olmez *et al* by offering blueberry pomace extract (BE) in broiler chickens.

Table 2: *Effect of FW supplementation on feed intake of broilers.*

Weeks	D1 (0%)	D2 (25%)	D3 (50%)	D4 (75%)
1st	215± 0.577[b]	223± 0.577[a]	211± 0.577[c]	193± 0.577[d]
2nd	214±0.577[c]	250±0.577[a]	248±0.577[b]	203±0.577[d]
3rd	258± 0.577[d]	328±0.577[a]	320±0.577[b]	261±0.577[c]
4th	1001.667±0.882[d]	1351±0.577[c]	1481±0.577[a]	1411±0.577[b]
5th	1791± 0.577[b]	1731±0.577[c]	1941±0.577[a]	1351±0.577[d]

Mean figure bearing different superscripts row wise differ significantly (p>0.05). Data for all parameters were presented as mean ± S.E.M. Means with the same letter are not significantly different. T1 (control, no supplementation), T2 (supplemented with 25% FW), T3 (supplemented with 50% FW), T4 (supplemented with 75% FW).

Table 3: *Effect of FW supplementation on FCR of broilers.*

Weeks	D1 (0%)	D2 (25%)	D3 (50%)	D4 (75%)
1st	1.424±0.096[d]	0.171±0.010[a]	0.359±0.007[b]	0.7745±0.008[c]
2nd	0.958± 0.013[b]	0.633±0.088[c]	0.6±0.0577[a]	0.882±0.004[d]
3rd	0.982± 0.004[a]	0.531±0.011[b]	0.771±0.005[c]	0.666±0.120[d]
4th	3.240± 0.011[a]	0.781±0.010[b]	1.702±0.056[c]	1.060±0.011[d]
5th	2.395± 0.286[a]	1.341±0.011[b]	0.666±0.088[c]	0.767±0.009[d]

Mean figure bearing different superscripts row wise differ significantly (p>0.05). Data for all parameters were presented as mean ± S.E.M. Means with the same letter are not significantly different. T1 (control, no FW supplementation), T2 (supplemented with 25% FW), T3 (supplemented with 50% FW), T4 (supplemented with 75% FW).

Table 4: *Effect of FW supplementation on body weight gain of broilers.*

Weeks	D1 (0%)	D2 (25%)	D3 (50%)	D4 (75%)
1st	231±0.577[a]	113.63±0.882[d]	115.4±0.2[c]	134.33±0.882[b]
2nd	252.33±1.202[c]	115.63±0.289[b]	225.5±0.289[d]	591.5±1.014[a]
3rd	420.83±1.364[d]	635.56±0.296[c]	885.83±0.441[a]	866±0.577[b]
4th	514.33±0.601[d]	869.83±0.441[c]	1551.16±0.928[a]	1235.66±1.202[b]
5th	1102.66±1.453[d]	1201.5±0.764[c]	1620.5±0.289[b]	1681.5±0.866[a]

Mean figure bearing different superscripts row wise differ significantly (p>0.05). Data for all parameters were presented as mean ± S.E.M. Means with the same letter are not significantly different. T1 (control, no FW supplementation), T2 (supplemented with 25% FW), T3 (supplemented with 50% FW), T4 (supplemented with 75% FW).

The results of BE supplementation were shown significantly increased BW gain and reduced FI and FCR as BE inclusion levels increases (Olmez *et al.*, 2021). The fall in FCR, feed intake and body weight gain in the group fed orange trash without enzyme could be attributed to anti-nutritional chemicals in the peels (Erinle and Adewole, 2022). Furthermore, the high crude fiber content of orange peel reduces ration palatability, resulting in reduced feed intake. The findings had been related with the ones of Oluremi *et al.* (2007) who found that sweet orange rind may replace maize in broiler diets by up to 15% without negatively impacting performance. The findings were consistent with those of Ebrahimi *et al.* (2013, 2014), who investigated the result of different levels of dried sweet orange peel supplementation on broiler chicks growth performance and discovered that a diet containing 1.5 percent dried sweet orange peel appears to promote broiler feed intake and weight gain in the 1-21 days after hatching period. Okoleh *et al.* (2015) stated that the addition of banana leaf to broiler chicken diets influenced ultimate feed conversion ratio, daily body weight gain and live weight considerably (p<0.05). The treatments supplemented with banana peels performed better than the control group. Despite the fact that feed conversion ratio, daily body weight gain and live weight for birds on D2 and D3 were equal (p>0.05) that supplemented the FT 25%, D2 group had numerically larger daily weight gain and final body weight (5.03%) than birds on D3 supplemented with 50% fruit waste. Birds fed with banana leaf powder, D2 consumed less feed than D1 and D3, respectively. Herbs consist of energetic components that useful resource digestion. It also has antimicrobial and immune stimulant residences (Ghazalah and Ali, 2008). Aqueous extracts of leaves and fruit peels of Musa paradisica var.

sapientum demonstrated antibacterial efficacy against some species of bacteria, according to Alisi *et al.* (2008). As seen in the current study, this antimicrobial property may have improved food digestion and assimilation, resulting in a higher feed conversion ratio in treated birds. Bera *et al.* (2013) found no difference in the food intake or final body weight of mice given the banana peels. In Swiss albino mice, the extracts were shown to be safe. The current findings suggested that in broiler chicks banana peels may be used as a growth promoter. Ahmad *et al.* (2016) suggested that apple peels is comparable low estimated doses can be included as a good feed source for feed performance in broiler chicken feed without adverse effects their productive function or body characteristics. In the small intestine, dietary fruit pomaces were found to reduce digesta viscosity and increase the concentration of short chain fatty acids particularly acetic and butyric acid compared to control-fed birds (Colombino *et al.*, 2020). Butyric acid provides the suitable form of energy necessary for stimulation of growth of intestinal epithelial cells and mucin production and thus, maintaining the tight junction integrity at the intestinal level (Jung *et al.*, 2015; Peng *et al.*, 2009). Apple waste can be used as a natural antioxidant because it has ability to reduce serum.

Table 5: *Effect of FW supplementation on carcass characteristics of broilers.*

Parameters	D1 (0%)	D2 (25%)	D3 (50%)	D4 (75%)
Slaughter weight	1468.42±1.201^{d}	1839.25±0.577^{c}	2254.43±33.340^{b}	2397.083±0.507^{a}
Dressing %	79±0.577^{a}	78±0.577^{ab}	78±0.577^{ab}	71±0.577^{a}
breast meat	28.297±0.353^{a}	29.297±0.353^{a}	29±0.577^{a}	29±0.577^{a}
Thighs	18.303±0.349^{a}	19±0.577^{a}	19±0.577^{a}	20±0.577^{a}

Mean figure bearing different superscripts row wise differ significantly (p>0.05). Data for all parameters were presented as mean±S.E.M. Means with the same letter are not significantly different. T1 (control, no supplementation), T2 (supplemented with 25% FW), T3 (supplemented with 50% FW), T4 (supplemented with 75% FW).

Table 6: *Effect of FW supplementation on organs weight of broilers.*

Parameters	D1 (0%)	D2 (25%)	D3 (50%)	D4 (75%)
Gizzards	9.66±0.1202^{b}	11.16±0.44^{b}	9.7±0.058^{a}	11±0.578^{a}
Liver	1.89±0.0057^{b}	1.89±0.006^{a}	1.91±0.006^{b}	1.91±0.006^{a}
Heart	0.49±0.0057^{a}	0.5±0.006^{a}	0.51±0.006^{ab}	0.51±0.006^{a}
intestine	3.337±0.009^{b}	3.34±0.006^{ab}	3.35±0.006^{ab}	3.36±0.006^{a}
Pancreas	0.23±0.012^{a}	0.23±0.006^{a}	0.24±0.006^{a}	0.24±0.006^{a}
Lungs	0.646±0.018^{a}	0.64±0.006^{a}	0.65±0.006^{a}	0.66±0.006^{a}
Spleen	0.166±0.009^{a}	0.17±0.006^{a}	0.18±0.006^{a}	0.17±0.006^{a}
Kidney	0.733±0.015^{a}	0.72±0.006^{a}	0.74±0.006^{a}	0.73±0.006^{a}

Mean figure bearing different superscripts row wise differ significantly (p>0.05). Data for all parameters were presented as mean ± S.E.M. Means with the same letter are not significantly different. T1 (control, no supplementation), T2 (supplemented with 25% FW), T3 (supplemented with 50% FW), T4 (supplemented with 75% FW).

Table 7: *Effect of FW supplementation on blood chemistry of broilers.*

Parameters	D1 (0%)	D2 (25%)	D3 (50%)	D4 (75%)
White blood cells	106.80 ± 6.016^{c}	132.73± 0.274^{b}	143.71±0.424^{a}	143.90±0.53^{a}
Lymphocytes	101.83±5.282^{c}	119.26±0.006^{b}	125.33±0.004^{a}	125.33±0.258^{a}
Mid-range absolute count	7.12±1.134^{b}	6.04±1.033^{b}	11.21±0.004^{a}	11.39±0.163^{a}
Granulocytes	3.72±1.191^{c}	5.28±0.006^{b}	6.42±0.176^{a}	6.42±0.176^{a}
Red blood cells	4.22±1.096^{c}	5.22±0.014^{b}	7.35±0.004^{a}	7.52±0.169^{a}
Hemoglobin	39.82±0.889^{c}	46.35±0.006^{b}	48.77±0.019^{a}	48.50±0.177^{a}
Mean corpuscular hemoglobin concentration	39.82±1.494^{c}	46.35±0.237^{b}	48.77±0.056^{a}	48.50±0.195^{a}
Mean corpuscular hemoglobin	47.53±3.027^{c}	58.33±0.008^{b}	62.34±0.002^{a}	62.66±0.214^{a}
Mean corpuscular volume	119.66±7.205^{b}	132.55±0.205^{a}	137.87±0.189^{a}	137.63±0.056^{a}
Mean platelet volume	5.49±0.854^{c}	7.45±0.018^{b}	9.63±0.004^{a}	9.63±0.006^{a}

Mean figure bearing different superscripts row wise differ significantly (p>0.05). Data for all parameters were presented as mean±S.E.M. Means with the same letter are not significantly different. T1 (control, no supplementation), T2 (supplemented with 25% FW), T3 (supplemented with 50% FW), T4 (supplemented with 75% FW).

Blood metabolites

All blood components in broiler chickens have significant (p<0.001) differences among all the treatments fed with fruit waste (Table 7). Jawad *et al.* (2012) stated that specific hematological parameters such as red blood cells, hemoglobin, leukocyte, lymphocyte and the amount of protein has increased, and heterophils have decreased by each group. In contrast to our results, Ojabo and Adenkola (2013) reported non-significant difference between groups treated with 2.5% and 5% orange peel in terms of hemoglobin, volume and total number of erythrocytes in the blood (Ojabo and Adenkola, 2013). Results showed that in artemia-controlled groups and lymphocyte were above the control group, while leukocyte, as hemoglobin, mean corpuscular hemoglobin concentration, red blood cells, lymphocyte and heterophils were less in quantity than the control group. However, leukocyte, hemoglobin, red blood cells, mean corpuscular hemoglobin concentration were almost equal to the control group.

Carcass weight and organs weights

In this experiment, all the carcass component had non-significant (p>0.001) difference among all the treatments (Table 5). An experiment to evaluate the effect of the orange peels as a feed source on broiler chicken. They found that orange peel had no effect (p> 0.05) on the liver, kidneys, heart, bladder, spleen and gall bladder but had a significant effect (p <0.01) on gizzard as sweet levels increased. These results showed the similarity with those of Torres *et al.* (2013) described; there were no significant difference (p> 0.05) between treatments in the carcasses components of broiler chickens (Table 6). According to the Yin *et al.* (2022), there were no influence of on the relative weight of the spleen, cloaca bursa, thymus or liver of the broilers and also had no effect on the breast or leg muscles, semi-eviscerated or eviscerated carcass (Yin *et al.*, 2022).

Conclusions and Recommendations

The results of current study exhibited that different concentration of fruits peel like apple, banana and citrus differed significantly among all the treatments. Feed with concentration of 25 percent fruit waste and 50 percent fruit waste showed better results than the control treatments with basal diets. During the whole experiment, body weight gain and feed intake were gradually increasing as fruit peels waste concentration increasing among the treatments. In the poultry industry, it is suggested for enzyme supplementation to improve bird performance at a reduced cost by increasing the available energy content in wheat- and barley-based diets and by degrading anti-nutritional factors, like beta-glucans, beta-mannose, protease inhibitors, and lectins in corn-soybean diets. Moreover, the maize is more expensive than the fruit waste, its utilization in poultry feed would be beneficial to the poultry industry to decrease the production expenses that reduces the cereal competition between human and poultry for maize.

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Novelty Statement

Fruit wastage is a potential problem regarding pollution and wastage of crucial nutrients every day. Current study will help the thoughts to the usage of the fruits wastage from wastage place to the food table by utilization in chicken feed and meat production.

Author's Contribution

Muhammad Shahid Nisar: Planning experiment and supervised the work.
Ahmad Kamran Khan: Review the manuscript.
Ghulam Fatima: Performed experimental work, data collection, investigation.
Irfan Ahmed: Review an edit manuscript.
Khizar Sami Ullah: Planning the experiment and supervise the work.
Syeda Amber Hameed: Planning the experiment.

Conflict of interest

The authors have declared no conflict of interest.

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