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Some Selected Vegetable and Fruit Wastes for Poultry Feed

Yitbarek MB*

Department of Animal Sciences, College of Agriculture and Natural Resources, Debre Markos University, Ethiopia

***Corresponding author:** Yitbarek MB Department of Animal Sciences, College of Agriculture and Natural Resources, Debre Markos University, Ethiopia, Tel: +251911054673, E-mail tirumelk@gmail.com

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Abstract

This review was done to assess some selected vegetable and fruit wastes used as poultry feed and indicate the inclusion rate of them in poultry ration. Among vegetable wastes, culled carrots at 4% and carrot tops up to 15% inclusion level improved yolk colour. Dried tomato pomace and tomato seed could be incorporated in poultry rations at the level of 20% and 15% respectively, without any adverse effect. Cooked potatoes and sweet potatoes meal up to 40%; and peeled sweet potatoes up to 15% can be used for poultry ration. Cabbage waste can be included up to 50% in layers ration. Among fruit wastes, the dried apple and apple pomace can replace maize by 10-20% in broiler ration. Dried banana leaves replacing up to 10% of a standard conventional diet. Dried banana peels can be included from 7.5% to 10% in broiler diets Up to 10% citrus pulp can be included in laying hens. Mango kernel meal can replace up to 60% of maize in broiler finisher diets. Less than 15% pineapple bran and less amount of avocado meal can be included in poultry ration. Therefore, vegetable and fruit wastes can be included in poultry ration after appropriate processing to reduce feed cost and environmental pollution for maximum return.

Keywords: Fruit Waste; Poultry; Ration; Vegetable Waste

Introduction

The world poultry population in 2015 was 19.4 billion which accounts 35% of the global livestock production. The world poultry meat production in the same year was 111.8 million metric tons and the global egg production was 70.9 million tonnes. The world today is suffering from a serious shortage of livestock feed ingredients because of the rapid increase in human population and feed competition of people and livestock [1]. The poultry industry is gradually increasing in the world where protein concentrates are costly and used in formulating poultry diet that increased production cost. The total feed required to poultry in 2015 was 439 million metric tons which accounts 45% of the total world feed market [2]. In poultry production, the availability and cost of feed ingredients stand at the forefront which accounts 70-75 % of the total production cost [3]. The global price of feed ingredients such as maize, wheat, fish meal and soybean meal has increased by 160%, 118%, 186% and 108%, respectively in the last decade, while the price rise in livestock products such as poultry meat, pork, lamb and beef was only 59%, 32% , -37% and 142 % respectively [2].

However, about 1.2-2 billion tons of waste (around 30 to 50% from the total production) is produced globally per year. Per capita waste by consumers is between 95 and 115 kgs per year in Europe and North America, and 6 to 11 kgs in Sub-Saharan Africa and South/South-East Asia. The direct economic consequence of this wastage is estimated to be one trillion Dollar annually [4]. Globally less than 3% of food waste was recovered and recycled only. But over 97% of food waste generated ends up in the landfill and on the surface of the ground. Food waste that goes to the landfill breaks down anaerobically and produces methane; methane is 21 times more potent than Co_2 as greenhouse gas. Large amounts of wastes that are directly applied into the soil and pollute the environment. Utilization of feed from waste in diet formulation until now has been negligible. However optimistic findings were reported by some researcher about the utilization of these abundant and inexpensive wastes and leftovers as an alternative feed ingredient in poultry ration. Therefore, this review was critically done to give a piece of information about the utilization of some selected vegetable and fruit wastes for poultry feed by reviewed different literatures to run successful poultry production within the cheapest production cost.

Vegetable and Fruit Wastes

Vegetable Wastes

Carrot (*Daucus carota*): Carrots feed are usually cull (grade-out) or surplus carrots obtained during glut season of production. Other carrot products that occasionally are fed to livestock include the carrot tops and carrot pomace after extraction of juice. Fresh carrot contains 10% CP, 1.4% EE, up to 60% sugars, mostly sucrose (on DM basis). A rich source of vitamin C (300–700 mg/kg DM) and carotene, depending on the carrot variety; orange carrots contain 200–1000 mg/kg DM of β-carotene [5]. Carrot tops contain about 11–12% protein in the DM, 17% crude fibre and up to 18% ash, depending on the amount of residual dirt. Carrot juice residue has a relatively low protein content (7.7% DM) and a high amount of fibre (ADF 28% DM) [6].

Fresh carrots have become common as forage in organic egg production. In organic laying hens fed a diet supplemented with 70g/d of orange, yellow or purple carrots, a decrease in certain performance parameters (egg and yolk weight for all carrot color's, egg mass for orange carrots) but increased yolk color parameters and carotenoid content was noted. Purple carrots were beneficial for egg laying rate and egg and yolk mass production [7]. Giving egg-laying hens' access to maize silage, barley-pea silage and carrots as foraging materials decreased pecking behavior, thus improving animal welfare [8]. Dried carrot meal included at 8% in the diet of laying hens significantly improved yolk colour when compared with a wheat-based control diet. This improvement was similar to that obtained with a yellow maize-based diet. Carrots at 4% inclusion level also improved yolk color score. Body weight gain, egg production and feed conversion were not significantly affected [9]. Carrot tops fed at 15% to laying hens improved the ß- carotene content and the color score of egg yolk. This increase was obtained at 5% inclusion rate and did not affect egg weight, Haugh unit, egg-shape index, and strength and thickness of eggshell [10].

Tomato (*Lycopersicon esculentum* Mill.) waste: Tomatoes *(Lycopersicon esculentum* Mill.*)* are one of the major vegetables and second only to potatoes in terms of world production [11]. While the majority of tomatoes are sold fresh, a little more than one third of the production is processed for canning, tomato juice, tomato paste or puree, sauces and ketchup. After processing of tomato the by-products, which represent 5-13% of the whole tomato [12].

Pomace is the mixture of tomato peels, crushed seeds and small amounts of pulp that remains after the processing of the tomato for juice, paste and ketchup [12]. Tomato paste being the primary tomato product produced worldwide, tomato pomace is the main tomato by-product available for animal feed [13]. Skins (peels) are a by-product of the peeling of tomatoes used for canning. Skins can be removed by steam-processing, treated with liquid N or NaOH [14]. Tomato seeds are a by-product from the tomato cannery, notably from the production of de-seeded canned tomatoes [15].

Tomato pomace and skins are high-moisture products: Due to the high moisture content, artificial drying can be expensive and sun drying is preferable. The product should be dried until it is crispy. Once dried, tomato pomace should be ground and the dried product mixed thoroughly with the diet [16].

The chemical composition of tomato pomace was 93.2% DM, 6.2% Ash, 94% OM, 21.6% CP, 9.5% EE, 38.8% CF, 0.54 % Ca, 0.36% P [17]. Fat content can even exceed 20% if the seed proportion is high [18]. Tomato skins have a lower protein and fat content, and higher fibre content than pomace. Tomato skins also contain appreciable amounts of carotenoids (about 500 mg/kg DM), mostly in the form of lycopene [14]. Tomato seeds have a high protein (25–28% DM), fibre (54% ADF) and fat (20–24% DM) content [19].

Dried tomato pomace can be used in poultry feeds, but its high fibre limits the metabolizable energy (ME) content to 8.4-9.5 MJ/kg and thus its practical use in poultry feed formulation. Inclusion of dried tomato pomace in broiler diets is possible if taking into account its low energy value in feed formulation [20]. Growth performance and feed efficiency have been depressed even at low inclusion rates 3% in starters to 9% in finishers [21]. Increasing inclusion rates from 5 to 20% decreased performance linearly with a relatively small (6%) overall decrease in body weight at 20% inclusion rate. Young animals were more affected, and birds older than 28 days did not show a lower growth when 20% pomace was included in the diet. Carcass characteristics do not appear to be negatively influenced by dried tomato pomace [22]. The lycopene content could actually be an advantage, especially in hot climates, due to its antioxidant properties [23]. Several treatments have been proposed in order to improve the nutritive value of dried tomato pomace in poultry. No significant differences were found between heat treatments (hot air at 121 °C vs. sun drying) and soaking in alkali, and after these treatments a 10% inclusion rate of pomace in the diet increased performance [24]. An enzyme treatment (enzyme cocktail) failed to improve broiler performance [21]. It can be recommended at up to 5 - 8% of the diet for growers and up to 10 - 12% for finishers. Inclusion rates as high as 20% can be used after 4 weeks of age if the feed is well balanced in energy, but growth and feed efficiency could be reduced.

Dried tomato pomace was included successfully in diets for layers, which require a lower energy concentration than broilers [25]. It can be used as a substitute for wheat bran, which has similar energy content [26]. At inclusion rates below 10%, no effect on performance was recorded, while higher levels occasionally depress egg production [27]. However, in some experiments, levels of 16% to 20% pomace were tested without effecting egg production and body weight [28]. No major effect was found on egg weight, structural characteristics and overall quality [28,29]. Because of the pigment content of dried tomato pomace (lycopene, carotenoids), egg yolk color was enhanced by its inclusion in the diet [27]. Tomato extract could replace alfalfa extract for pigmentation of eggs [30]. Dried tomato pomace could be incorporated in grower chick rations at the level of 20% without any adverse effect on growth performance in order to increase the economic efficiency [17]. Dried tomato seeds have a much higher energy level than dried tomato pomace (more than 12.6 MJ/kg DM) due to their high fat content. Tomato seeds tested in the diets of chicks (8-21 days of age) resulted in a similar performance as a control diet up to 15% inclusion, but at 20% growth was slightly reduced [19].

Potato (*Solanum tuberosum L.*): During the peak production season, it becomes a problem for the farmers to dispose of the surplus and the cull potatoes. The only option for the farmers is to feed them to the livestock. To get the most value from the starch present in potatoes, these should be boiled or steamed. Potato sprouts contain an alkaloid, solanine and it is advisable to remove the sprouts before the potatoes are fed to pigs or poultry. Fungal infested potatoes should never be used as feed.

The fresh potatoes contain 65-75% starch (depending on the variety). The dried potato leaves contain 91.2% DM, 10.8% Ash, 17.5% CP, 6.4% EE, 39.1% CF, 1.39% Ca, 0.14% P and 19.3 MJ/KgDM GE [31]. Potato peals fresh contains 17.8% DM, 6.1% Ash, 13.1% CP, 0.5% EE, 3.3% CF, 0.08% Ca, 0.26% P and 17.2MJ/KgDM GE [32]. Potato tuber raw contains 20.2% DM, 7% Ash, 10.8% CP, 0.5%EE, 2.5% CF, 0.07% Ca, 0.22% P and 16.92MJ/KgDM GE [33]. Cooked potatoes can be used for poultry to which they have been fed successfully in proportions of up to 40% of the total ration [34].

Sweet potato [*Ipomoea batatas* (L.)] waste: Sweet potato [*Ipomoea batatas* (L.) Lam] is a plant grown for its tuberous roots in tropical, subtropical and warm-temperate regions. Cooking improves the feeding value of the tubers since it reduces trypsin inhibitors and improves starch digestibility [35]. Tubers used for animal feed are cleaned, shredded or sliced, treated with sulphur dioxide and dried rapidly, in the sun or in hot air drier at 80°C or higher. The dried product is fed whole or ground to poultry [36]. Sweet potato tubers are mainly an energy source due to their high carbohydrate content, which accounts for 80-90% of the dry weight. These carbohydrates consist of starch, sugars and small amounts of pectins, hemicelluloses and cellulose [37]. Starch is the main carbohydrate (about 75% DM) and is very resistant to amylase hydrolysis. The dry matter content of fresh tubers is about 30% and up to 45% in some varieties [38]. Tubers are a poor protein source, as they contain about 4% DM of crude protein, less than half that of maize grain and are poor in lysine and sulphur-containing amino acids [35]. They have low contents of fibre (7% DM of NDF), fat and ash.

Sweet potato meal can be successfully used as a substitute for maize in broiler diets, but in most cases the highest substitution levels decrease performance. The recommended inclusion level is usually 20%. For example 25% sweet potato meal plus 10% molasses could profitably replace maize in growing chick rations [39]. However, up to 30-40% sweet potato meal in the diet did not alter performance in some experiments [40]. In some cases, inclusion levels higher than 10% reduced performance [41]. Sweet potato has been used in layer diets, but a general trend of decreasing performance has been reported. Safe inclusion rates should be limited to between 10 and 15% sweet potato meal in the diet, with proper protein and vitamin A supplementation. Replacing 50% of maize with a mixture of sweet potato meal (21% of the diet), wheat bran and sweet potato leaf meal was found to be acceptable though it significantly reduced egg production by 5.6%. Total replacement of maize (42% of the diet) decreased performance [42]. A similar significant decrease in egg production (- 11.6%) was observed when substituting maize with sweet potato meal at 20% of the diet, whereas the decrease (- 4.2%) was not significant at 10% [43]. About 15% inclusion of peeled sun-dried sweet potato meal maintained egg production, while higher rates tended to reduce performance, though only significantly at rates higher than 45% Table 1 [44].

Feed stuffs	DM %	Ash %	OM %	CP %	EE %	CF %	Ca g/kgDM	P g/KgDM	Source
Tomato pomace	93.2	6.2	94	21.6	9.5	38.8	5.4	3.6	Melkamu, 2013 [17]
Tomato skin	92.7	3.3		19.8	-	-	-	-	Alibase, *et al*. 1990 [46]
Carrot tops fresh	16.4	17.4		11.7	2.3	16.7	20.1	4.5	Bezzera, *et al*. 2005 [47]
Carrot roots fresh	10.7	7.4		9.1	1	10	3.8	2.9	AFZ, 2011 [33]
Potato leaves dried	91.2	10.8		17.5	6.4	39.1	13.9	1.4	Chopra,1970 [31]
Potato peels fresh	17.8	6.1		13.1	0.5	3.3	0.8	2.6	Vanlunen, *et al*.1989 [32]
Potato tuber raw	20.2	7		10.8	0.5	2.5	0.7	2.2	AFZ, 2011 [33]
Sweet potato tuber	88	3.1		4.6	1.3	2.8	1.7	1.8	Chanjula, *et al*. 2003

Note : DM-Dry Matter; OM-Organic Matter; CP- Crude Protien; EE-Ether Extract; CF Crude Fiber; Ca-Calcium; P-Phosphorus; GE- Gross Energy; g- gram; Kg–Kilo gram; MJ Mega Joule

Table 1: Chemical composition of vegetable wastes in dry matter basis

Cabbage waste: Cabbage waste can be offered as a feed to livestock in 3 forms as fresh, meal, and silage form. It is a good source of protein and can be used for feeding of poultry. According to the report of Anil the cabbage waste was provides as a form of green, meal and silage for white leghorn layers and he reported that the highest dry matter consumption was seen in birds fed with cabbage offered in the form of silage incorporated at 50% and highest hen day average egg production was seen in birds fed with cabbage waste in the form of silage incorporated at 40% level, lower feed costs were observed in the groups that are fed cabbage waste in the form of silage [45].

Fruit Wastes

A fruit waste is obtained from culled or damaged fruits and after juice extraction.

Apple Pomace (*Malus domestica*)
Out of the total world production, 30 - 40% of apples are damaged and therefore not marketed, and 20–40% is processed for juice extraction. The residue left after extraction of the juice, called apple pomace, could be used as a livestock feed. Processing of the apple pomace was done by heaping the fresh waste for drain of more water and presses mechanically to allow excess drain. About 25 to 35% of the fresh weight of the apple is retained in the pomace after pressing. Dry the waste by thermal drying or by blowing hot air or by using a solar drier. In case a mechanical press or thermal drying facilities are not available, then the waste may be spread in a 5 - 7 cm thick layer on a concrete floor under direct sunlight for sun drying. Turn the material upside down with a fork, 2-3 times a day, till the dry matter reaches around 90%. Ground the dried waste in a mill using 1 - 2 mm screen. Store the ground waste in polythene bags and use as and when required. Nutrients in the dried apple pomace was 7.7 % CP, 5 % EE, The ME of apple pomace for broilers is 2.6 - 2.8 Mcal/kg DM [48]. The dried apple pomace can be used as an energy source in broiler rations replacing maize by 10% without adversely affecting the broiler production. Incorporation at >10% leads to production of wet litter and depresses feed efficiency, mainly due to higher fibre content. Matoo, *et al.* have reported better performance of broilers fed on apple pomace diets supplemented with a commercial enzyme preparation (*α-amylase,* hemicellulase, protease and *β-glucanase*) compared with those that were not supplemented [50]. The dried, ground damaged apple can replace 20% maize in broiler ration without any harmful effect and thus decreasing the feed cost.

Banana (*Musa acuminata*) Leaves and Peels: About 30–40 % of the total banana production is rejected for failing to meet quality standards and is potentially available for feeding to livestock [51]. Banana wastes include small-sized, damaged bananas, banana peels, leaves, young stalks and pseudo stems, which can be fed to livestock. Banana leaves contain about 15% DM and 10–17% CP, while pseudo stems contain 5–8% DM and 3–5% CP. Banana leaves contain 8% polyphenols, but very few condensed tannins [52]. Banana peels are the outer envelopes of banana fruits. Banana peel constitutes about 30% of fresh banana by weight. Ripe banana peels contain up to 8% CP and 6.2% EE, 13.8% soluble sugars and 4.8% total phenolics [53]. Green peels have approximately 15% starch which gets converted to sugars as the fruit ripens and the ripened peel has approximately 30% free sugars. Dried plantain leaves replacing 10% of a standard conventional diet in broilers did not affect feed efficiency or feed conversion [54]. Maximum inclusion rates of 7.5% and 10% dried banana peels have been suggested for broiler diets. In one experiment, dried plaintain peelings replacing maize grain resulted in a significant decrease of the weekly weight gains when included at more than 7.5% in the diet [55]. In another experiment, live-weight gain and feed conversion efficiency were significantly higher in chickens fed up to 10% banana peel meal in the diet. Feed intake increased linearly as the level of peels increased to 10%, after which growth decreased [56].

Citrus pulp: About 30% of the production of citrus fruits (and 40% of orange production) is processed principally to make juice [57]. The residue left after extraction of the juice is called citrus pulp (50–70% of the fruit by weight). It contains 60 - 65% peel, 30–35% internal tissues and up to 10% seeds [58]. Citrus pulp is usually made from oranges (60%), grapefruits and lemons. It should be sun dried and pelleted to increase density or should be ensiled while drying, lime is added to neutralize the free acids, bind the fruit pectins and release water [59].

It contains 5 - 10% CP and 6.2 % EE, 10 - 40% soluble fibre (pectins) and 54 % water soluble sugars, 1 - 2% calcium due to the addition of lime and 0.1% phosphorus [53]. Citrus pulp is a rich source of trace elements and their concentration is much below the maximum tolerance limit for ruminants. It is much less valuable to pigs and poultry due to the fibre content and to the presence of limonin in the seeds, which is toxic to monogastrics [60]. The level of citrus pulp in the diets of poultry should not exceed 5 - 10% because of the presence of non-starch polysaccharides which impaired growth rates, lowered feed efficiency and reduced carcass yields [61]. But within these limits (up to 10%) it did not affect feed intake, egg production, and egg weight in laying hens [62].

Grapes (*Vitis vinifera L*) Pomace: Grapes are mainly used for wine making. Winery waste and by-products as percent of grapes include grape stalks (2.5–7.5%), grape pomace (~15 % dry; wet up to 25–45%) and grape seeds (3–6%) and yeast lees (3.5–8.5%). yeast lees are the residual yeast and other particles that precipitate at the bottom of a wine vat. Grape pomace contains up to 15% sugars, 0.9 % phenolics/pigments (red grape pomace), 0.05–0.08% tartarate and 30–40 % fibre,9–12%CP and 5–7% EE. Grape seeds contain 4–6% phenolics and 12–17 % oil very rich in linoleic acid-omega-6 fatty acid (76 percent). The yeast lees contain 0.012% pigments, 0.1–0.15% tartrate and 6–12 percent β 1, 3-glucans. The utilization of grape in broiler diets could use up 6% without significant effect on growth performance. Also economically grape pomace is a good alternative for corn and soybeans [63].

Mango (*Mangifera indica L.*) Seed Kernels: The edible pulp makes up 33–85% of the fresh fruit, while the peel and the kernel amount to 7–24% and 9–40%, respectively, on a fresh weight basis [64]. The by-products/wastes available after processing of mango includes cull fruits (fresh fruits unsuitable for human consumption), mango kernel meal (containing 6–16% mango oil on DM basis), deoiled mango kernel meal and mango peels. Mango seed kernels (mango kernels) is the kernel inside the seed represents from 45% to 75% of the whole seed [65]. Mango seed kernels (MSK) contained carbohydrate (69.2 –80%), protein (7.5 – 13%), fibre (2.0 – 4.6%), ash (2.2 –2.6%), calcium (0.21%) and phosphorus (0.22%), which is comparable to that of maize, depending on the variety [66]. The kernel is also balanced in amino acids [67].

In broiler chicks, the inclusion of raw mango seed kernel meal generally results in degraded performance. Inclusion rates as low as 5 to 10% depressed growth and feed intake in some experiments while reported that performance was maintained at 10% inclusion rate [68]. The incorporation of 5% raw mango seed kernel meal in layers decreased laying rate and increased weight loss in layers [68]. Daily feed intake and feed conversion ratio were significantly improved on the 60% mango kernel diet inclusion compared to the control diets. Diarra, *et al.* concluded that up to 60% of the maize in broiler finisher diets can be replaced with boiled mango kernel meal without adverse effects on the growth, health and carcass parameters [66]. Diarra, *et al*. reported that boiled mango kernel meal can replace 50% of maize in the diets of broiler chicks and up to 75 % in the finisher diets. Similarly, Faniyi reported that broiler birds can utilize up to 30% level of mango seed kernel meal as an energy source during starter and finisher phases but that appropriate protein and metabolizable energy (ME) requirements of the birds should be taken care of in the diets [70].

Pineapple (*Ananas comosus*) Bran: The post-harvest processing of pineapple fruits yield skins, crowns, and wastes from fresh trimmings and the pomace after extracting the juice. Fresh pineapple cannery waste can be preserved either by drying or ensiling. Pineapple bran is the solid residue of the pressed macerated skins and crowns. It can be fed either fresh, ensiled or after drying to the animals. Wet pineapple bran can be sun-dried in 3 days, or artificially dried within 1 day (after preliminary pressure) [68]. Partial or complete sun-drying is possible, but hazardous in the rainy season [71].

The composition and nutritive value of pineapple wastes varies with the ratios of by-products they include, the variety of the fruit, its ripeness and the cannery technology employed. The amount of nutrients (particularly sugars) in the wastes decreases when the efficiency of the juice extraction increases [72]. Raw pineapple waste (on DM basis) contains 4 - 8% CP, 60 - 72% NDF, 40 - 75% soluble sugars (70% sucrose, 20% glucose and 10% fructose) as well as pectin, but it is poor in minerals. Therefore, it should be supplemented with protein and minerals in order to prevent detrimental effects on productivity and health. Inclusion of 15% pineapple bran in chick diets depressed the feed conversion ratio and 20% inclusion decreased weight [73].

Avocado *(Persea americana)* waste: In the avocado (*Persea americana*) fresh fruit industry, avocado meal is a waste product consisting of oil-extracted avocado fruits that were unsuitable for the fruit market. The residue is considered a waste product that creates a disposal problem. From the chemical composition of the product it seems to be a potential feedstuff for animals, specifically as an energy source [74]. It was concluded that antinutritional substances in avocado meal such as high levels of condensed tannin and crude fibre probably contributed to the poor performance of the birds Table 2.

Feed stuffs	DM %	Ash %	OM %	CP %	EE %	ADF	Ca g/Kg DM	P g/KgDM	Source
Apple Pomace	35.9	2.6	97.4	7.7	5	43.2	2.0	1.4	Bakshi & Wadhwa, 2013 [53]
Banana peels	9.4	11.1	88.9	8.1	6.2	25.3	2.9	1.8	Bakshi & Wadhwa, 2013 [53]
Citrus pulp	9.5	4.5	95.5	10.5	5.8	24.5	4.9	1.4	Bakshi & Wadhwa, 2013 [53]
Grape pomace	92.3	7.1	92.3	16.6	10.2	28.5*	8.5	3.1	AFZ, 2011 [33]
Mango peel	92.2	6.1	-	4.6	3.8	12.6*	8.1	2.8	Sanon, *et al*. 2010 [75]
Mango Kernel	91.9	2.9	-	7.5	12.7	2.9*	4.4	2.8	Barman, *et al*. 2006 [76]
Avucado peels	90.1	7.6	-	8.2	3.1	21.9*	-	-	Bakshi & Wadhwa, 2013 [53]
Pinapplebyproducts	88.6	8.2		4.5	1.2	17.8	4.9	1.3	CIRAD,1991 [77]

Note :* depicts CF content. :DM-Dry Matter; OM-Organic Matter; CP- Crude Protien; EE-Ether Extract; CF Crude Fiber; Ca- Calcium; P- Phosphorus; g- gram; Kg- Kilo gram; MJ Mega Joule

Table 2: Chemical compositions of fruit wastes for poultry feed

Conclusion

The annual waste production in the world reaches 1.2-2 billion; however, almost 97% of such wastes are not recycled and hazardous for environmental pollution [78]. Now days the cost of poultry ration is alarmingly increasing and birds are computing with the human food. Therefore, after following the procedures of appropriate processing methods of vegetable and fruit wastes, it should be used as a source of alternative feed ingredient in poultry ration. Heating, cooking, steaming, and sun drying are among the drying methods of such wastes. Based on the this review it can be recommended that by using appropriate processing method, incorporating these waste as feed ingredients in poultry ration according to the recommended inclusion level helps to reduce the overall poultry production cost and environmental pollution.

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