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Investigation of parameters in restaurant food waste for use as poultry rations

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Abstract

One way to use food industry wastes is to feed the livestock and poultry. Applying appropriate management methods for the optimal use of agricultural waste in the preparation of livestock and poultry feed increases productivity and reduces damage to agricultural and conversion industries and the use of new resources in animal and poultry feed. In this paper, in order to investigate the possibility of recycling food waste as poultry feed, the waste produced in a restaurant has been used. The parameters of fat percentage were measured using Soxhlet extractor, percentage of dry matter using the oven, percentage of protein in it using Kjeldahl method, and also the percentage of calcium and phosphorus with the standard beard. Comparing them with the usual diet used in poultry feed shows that the average values of calcium, protein, and fat content of food waste are 0.14%, 5.65%, 7.34% higher than the average diet of poultry, respectively. Also, the average amount of phosphorus and dry matter of food waste is 0.48% and 60% less than the average diet of poultry, respectively.

Keywords: waste management; restaurant food waste; poultry rations; recycling.

Practical Application: In the current study the parameters in restaurant food waste has been investigated in order to use as poultry feed.

1 Introduction

Food waste is produced especially in the agricultural, industrial, and urban sectors of society, including by wholesalers and consumers (Seidavi et al., 2020; Molajou et al., 2021). Utilization of such wastes requires urgent research as recycling and reduction of residues can reduce pollution and improve the current situation by preparing new feed from the residues (Chen et al., 2020; Barreira et al., 2021). The use of animal waste, summer crops, and fruits in animal and poultry feed for indirect production of feed from food waste is very valuable (Kim et al., 2020). Food leftover from restaurants, homes, or other establishments is often disposed of as waste due to its high humidity and perishable nature (Ojha et al., 2020; Burzyńska, 2019). It causes water and soil pollution in landfills (Sharma et al., 2020). They may also contaminate other wastes and disrupt the incineration of other wastes. As a result, management programs are needed to recycle waste (Olszewska et al., 2020) properly. Due to rapid population growth and increasing demand for food, the amount of food waste produced in urban communities is increasing rapidly (Chen et al., 2012; Galhardo et al., 2021). Various management methods are being implemented for food waste recycling, including composting, anaerobic digestion, burning or feeding livestock and poultry (Ramos & Nascimento, 2020). In livestock and poultry breeding centers, most of the operating costs are related to the cost of feed supply, so using cheap feed can reduce production costs and thus the cost of poultry (Chander & Kannadhasan, 2021). Restaurant waste, as part of food waste, can have a high nutritional value for poultry and, on the other hand, can reduce environmental pollution, reduce the cost of waste disposal, as well as reduce competition between animals and humans in the use of valuable food resources (Seidavi et al., 2018).

Today, food waste is being used in various countries (Walker et al., 2002; Rabêlo et al., 2021). Recycling food waste and replacing it with poultry rations is one of the most important projects pursued by the South Korean government. Also, replacing food waste as feed-in poultry diets is known as a solution for food waste recycling in the United States (Sakaguchi et al., 2018). Japan

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also recycles a significant percentage of food waste produced for livestock and poultry feed (Westendorf et al., 1998). Recycling food waste and the production of functional products from it is very important because, in addition to reducing food imports, it can also help reduce environmental pollution (Cho et al., 2004).

It should be noted that the direct use of food waste in poultry feed without their processing can lead to the spread of pathogens and infections. Therefore, proper processing and disinfection of these materials is an important issue that requires great care (Ali et al., 2021; Arifjanov et al., 2021). Wet and unprocessed feed, due to its high moisture content, disrupts nutrition, reducing dry matter intake by reducing product shelf life. By studying various methods of conversion and processing of food waste, it is possible to effectively disinfect and clean food waste by performing heat treatment at a certain time and at the appropriate temperature. Although heat treatment causes some of the nutrients to be lost, the remaining nutrients can still meet the nutritional needs. In this paper, the nutritional value of food waste in comparison with the compounds used in the preparation of poultry feed has been investigated. Therefore, the purpose of this paper is to determine the nutritional value of restaurant waste and the possibility of replacement with poultry rations (Galal et al., 2020; Ferreira et al., 2021).

2 Material and methods

This section describes the method of sampling food waste and performing tests to measure the percentage of fat, dry matter, calcium, phosphorus, and protein.

2.1 Sampling method

In this paper, restaurant food waste has been used. Randomly sampled food waste was done for seven consecutive days, and the collected waste samples included red meat, fish, chicken, rice, and legumes. All experiments were performed in 5 replications.

2.2 Fat measurement

A Soxhlet extractor device and filter paper No. 42 were used to measure the amount of fat in the samples. First, the weight of the filter paper was measured. Three grams of samples were poured on paper, and after folding it, the samples were placed vertically inside the machine. 100 cc of hexane per sample was poured into the tank and stored at 70 ° C for 4 hours to evaporate and condense the hexane, and their fat was completely washed away. After 4 hours, the samples were removed from the device and placed in a desiccator for 2 hours in order to completely evaporate the hexane. The samples were placed in an oven for 24 hours to dry. Finally, the total weight was measured, and the paper weight was subtracted from the sample weight, and the fat percentage was obtained from the following equation (Equation 1).

$$fat\ percentage = \frac{\text{Final weight} - \text{Initial weight}}{\text{Sample weight}} \times 100 \tag{1}$$

2.3 Dry matter measurement

The total amount of food without considering the percentage of moisture is called the percentage of dry matter. This section contains protein, fat, crude fiber, and minerals in the food. Moisture content is obtained by drying the food and calculating the weight loss. In this paper, in order to measure the amount of dry matter in food waste, food waste was first poured into a mixer and mixed at medium speed for 3 minutes. The mixed mixture was weighed and placed in glass containers in an oven at 70 °C for 48 hours. After 48 hours, remove the mixture from the oven and place it in the desiccator for 2 hours until it reaches ambient temperature. The dried sample was ground at medium speed for 5 minutes, and then the residual weight was measured (Equation 2).

$$Percentage\ of\ dry\ matter = \frac{\text{Dry sample weight}}{\text{Wet sample weight}} \times 100 \tag{2}$$

2.4 Measurement of protein

Protein is a major component in the structure of waste. It is found in the structure of muscles, skin, blood cells, hormones, as well as bone tissue (An et al., 2019). In this paper, the following method was used to measure the amount of protein in the waste. First, nitrogen, protein, and other acid-digesting compounds were converted to ammonium sulfate using concentrated sulfuric acid. After cooling, the acidic digestion product was diluted with distilled water, and then in the distillation step, ammonia was released by adding an alkali (sodium hydroxide) to the digested mixture. The released ammonia was adsorbed on boric acid and then released during the titration of ammonia bonded with boric acid (ammonium borate complex) using a standard acidic solution (sulfuric acid). The reactions that took place in each step are as follows (Equations 3-7).

$$Sample + H_2SO_4 \rightarrow NH_3 + CO_2 + SO_4 + NO_2 \tag{3}$$

$$2NH_3 + H_2SO_4 \rightarrow (NH_4)2SO_4 \tag{4}$$

$$(NH_4)2SO_4 + 2NaOH \rightarrow 2NH_4OH + Na_2SO_4 \tag{5}$$

$$NH_4OH + H_3BO_3 \rightarrow NH_4B(OH)_2 \tag{6}$$

$$2NH_4B(OH)_2 + H_2SO_4 \rightarrow (NH_4)2SO_4 + 2H_3BO_3 + 2H_2 \tag{7}$$

Because the average amount of nitrogen in biological materials is about 16% based on dry matter, usually, to measure the crude protein content, the total nitrogen measured must be multiplied by a factor of 6.25. Finally, the percentage of protein was calculated using the following equation (Equation 8).

$$Percentage\ of\ dry\ matter = \frac{\text{The amount of protein in the sample}}{\text{sample weight}} \times 100 \tag{8}$$

2.5 Measurement of calcium

In this paper, in order to measure the percentage of calcium in food waste, the sample was first placed in an oven at 70 °C for 48 hours. After drying, 1 g of each sample was poured into a porcelain dish and burned in an electric oven at 550 °C, and the sample ash was prepared. Calcium was measured by titration with potassium permanganate. To do this, 20 cc of ash solution was transferred to a beaker, and about 100 cc of distilled water and two drops of methyl reagent were added. Using pH meter and pH ammonium hydroxide solution, the solution was reduced to about seven and titrated with 0.1 potassium permanganate tetrazole solution until pink.

2.6 Phosphorus measurement

To measure the percentage of phosphorus in food waste, first, a dried sample of the product was prepared, and 1 g of it was burned in an electric oven at 550 °C, and the sample ash was prepared. A spectrophotometric method was used to measure phosphorus. For this purpose, 5 cc of the ash solution is transferred to a 100 cc volumetric flask, 25 mL of the vanadate-molybdate reagent is added, and the volume is increased. After complete mixing, leave for 10 minutes, then the adsorption intensity of the solution was measured at 420 nm against the empty solution. The concentration of phosphorus was obtained from the adsorption intensity, and the final result was calculated according to the amount of the sample solution.

3 Results and discussion

In this section, the values obtained for calcium (Ca), phosphorus (P), dry matter (DM), crude fat (CF), and crude protein (CP) are presented and compared with normal poultry ration values.

3.1 Examine the usual poultry rations

Poultry rations are mainly composed of corn, corn gluten, wheat, barley, wheat bran, soybean meal, and sunflower meal (Dou et al., 2018). Table 1 lists the amounts of calcium, phosphorus, dry matter, crude fat, and crude protein in each of these foods.

3.2 Investigation of measured parameters in restaurant food waste

The amounts of calcium, phosphorus, dry matter, crude fat, and crude protein of the food waste tested are presented in Table 2.

3.3 Comparison of calcium percentage

Calcium is essential for the formation of bones and eggshells. This mineral is formed in the bone as calcium phosphate and in eggshells as calcium carbonate. When egg production begins, the calcium needed to form the eggshell comes from the calcium in the diet and the bones (Chen et al., 2015). In contrast, increasing calcium intake also reduces its absorption. Therefore, the amount of calcium consumed should be adjusted according to the table of nutritional needs. A comparison between the percentage of calcium in restaurant food waste and the percentage of calcium in products used in the preparation of poultry rations is shown in Figure 1. According to the diagram, it can be seen that the percentage of calcium in all five samples tested is almost the same, but the percentage of calcium in the products used in poultry diets is different, and this difference depends on the type of application. Considering the average percentage of calcium in food waste and comparing it with other items in the poultry diet, it can be expected that replacing food waste with soybean meal will have positive effects on growth and feed consumption. However, since excessive calcium intake in poultry has a negative effect and causes calcium excretion, complete replacement of food waste with poultry rations requires further research and study on live poultry.

Table 1. Values of basic parameters in poultry diets.

Poultry rations	Ca%	P%	DM%	CF%	CP%
Corn	0.02	0.3	88	4.3	6
corn gluten	0.11	0.84	90	3.2	22
barley	0.06	0.38	89	2.1	11.3
wheat	0.05	0.43	89	2.3	14
wheat bran	0.14	1.2	89	4.6	12.5
soybean meal	0.29	0.66	88	18.8	41
sunflower meal	0.4	1.03	91	2.4	31

3.4 Comparison of phosphorus percentage

A comparison of the percentage of phosphorus in food waste and products used in the preparation of poultry feed is given in Figure 2. According to the diagram, it can be seen that the percentage of phosphorus in food waste is very low, and these materials could not be replaced with poultry diets to meet the needs of poultry phosphorus.

3.5 Comparison of dry matter percentage

A comparison of the percentage of dry matter in food waste with the materials used in the preparation of poultry rations is given in Figure 3. According to the chart, it can be seen that the percentage of dry matter in food waste is about one-third of the dry matter of diets. This is obvious considering the nature of food waste because this waste has very high humidity. As a result, from a dry matter point of view, waste could not be used in poultry feed. However, due to the fact that no other by-products were used in the processing of waste in this paper, and since bread waste is produced in abundance in restaurants and this waste has a high percentage of dry matter, it is possible to use dry bread waste, improves dry matter content in combination with food waste.

3.6 Comparison of protein percentages

A comparison of the percentage of protein in food waste with the products used in the preparation of poultry feed is given in Figure 4. According to the chart, the percentage of protein in

Table 2. Measured parameter values in restaurant food waste.

Food waste	Ca%	P%	DM%	CF%	CP%
Red meat and rice	0.31	0.25	27.82	12.38	21.91
Fish and rice	0.28	0.25	29.12	10.1	17.95
Chicken and rice	0.24	0.15	31.58	12.25	30.42
Cereals and rice	0.33	0.11	29.27	8.2	33.27
Fried chicken	0.28	0.29	27.23	20.7	25.25

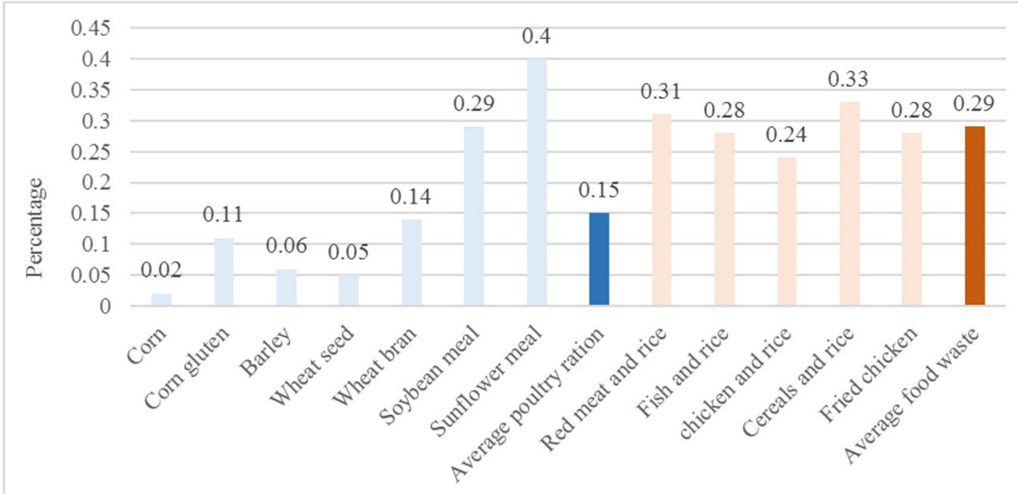

Figure 1. Comparison of the percentage of calcium in restaurant food waste with poultry rations.

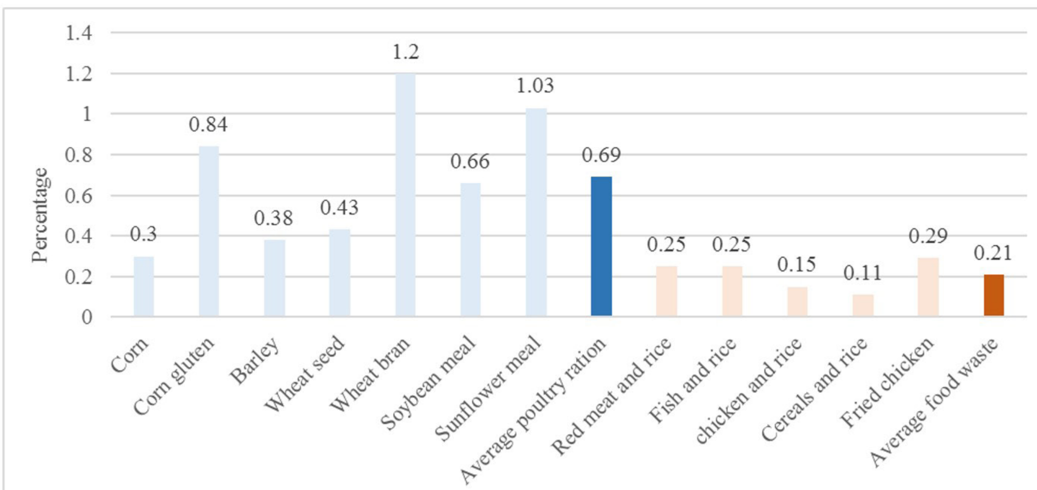

Figure 2. Comparison of the percentage of phosphorus in restaurant food waste with poultry rations.

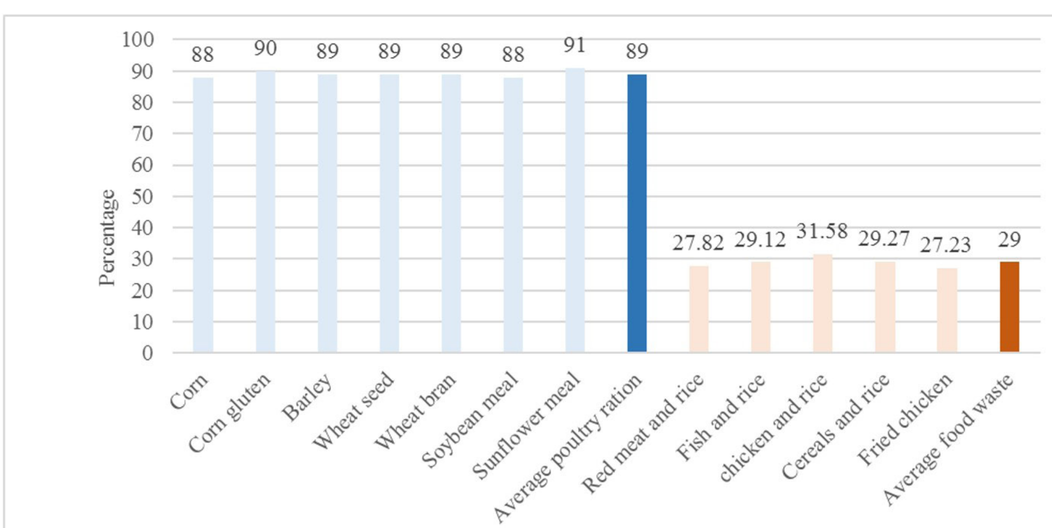

Figure 3. Comparison of dry matter percentage of restaurant food waste with poultry rations.

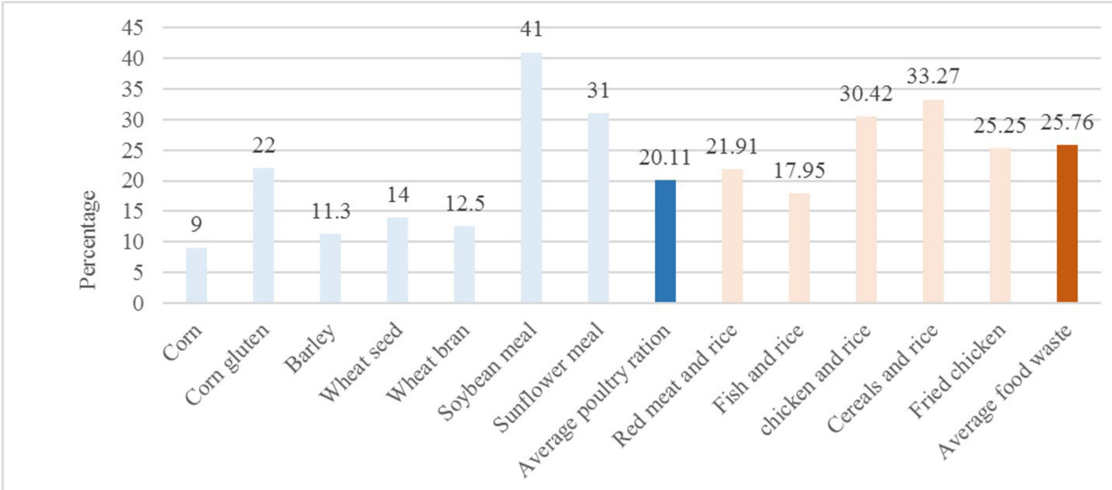

Figure 4. Comparison of the protein content of restaurant food waste with poultry rations.

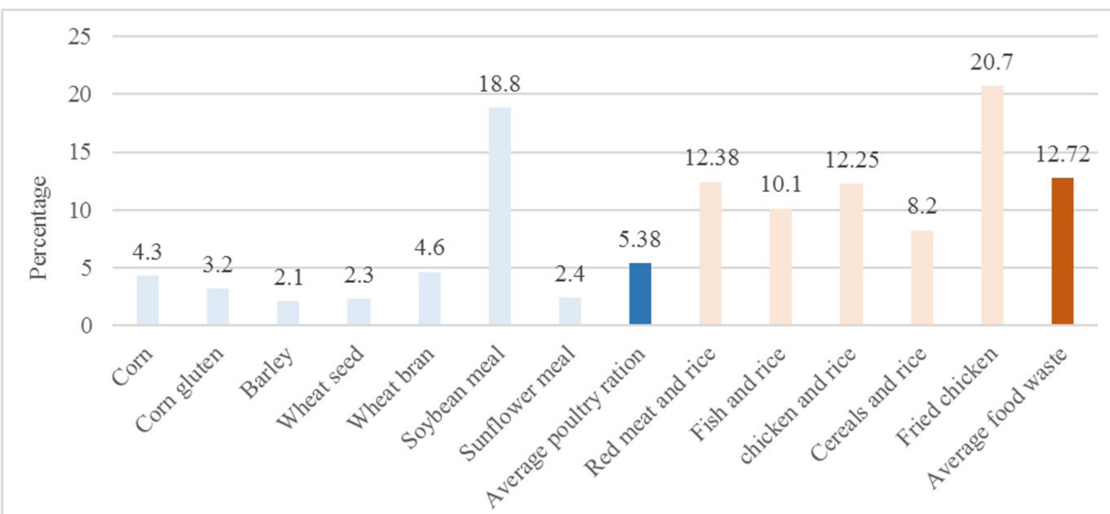

Figure 5. Comparison of the fat content of restaurant food waste with poultry ration.

food waste is higher than all cereals and is only slightly different from the percentage of protein in soybeans and sunflower meals. Due to the structure of soybean meal and sunflower meal as processed food that is used as a source of protein and by comparing the means of the two groups, it can be said that the percentage of protein in food waste can be replaced with protein in poultry diets.

3.7 Comparison of fat percentage

A comparison of the percentage of fat in food waste with the percentage of fat in products used in poultry diets is shown in Figure 5. According to the chart, it can be seen that the average percentage of fat in food waste is higher than the average fat in poultry rations. The percentage of fat in soybean meal and its importance in the growth and weight of poultry, and based on the fact that the presence of fat in poultry diets is important and necessary, it can be expected that the replacement of food waste with poultry rations along with other nutrients, need to have positive effects on poultry weight and growth. In general, experiments on live poultry can be more useful in order to examine the subject more closely and achieve more credible results.

4 Conclusion

The following can be deduced from the above points about restaurant food waste and studies on dry matter, protein, calcium, phosphorus, and fat parameters. The average dry matter of restaurant food waste is about 60% less than the average poultry ration, which indicates that in terms of dry matter, food waste is not a suitable substitute for poultry ration. The average calcium of restaurant food waste is about 0.14% higher than the average diet of poultry. The average calcium in food waste is close to the amount of calcium in soybean meal, which can be replaced with this part of the poultry diet. The average phosphorus of restaurant food waste is about 0.48% less than the average poultry diet, indicating that food waste is not a suitable substitute for poultry rations in terms of phosphorus. The average crude protein of restaurant food waste is about 5.65% higher than the average poultry ratio. In this case, food waste can be used as a substitute for poultry rations. The average crude fat of restaurant food waste is about 7.34% higher than the average poultry ratio. In this case, food waste can be used as a substitute for poultry rations. In this paper, the numerical values of the basic parameters between poultry rations and restaurant food waste have been compared, but for a definite replacement with poultry rations, several experiments should be performed on live poultry.

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