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Research Article

Effects of Dietary Sweet Orange (*Citrus sinensis*) Waste on Crude Protein Digestibility and Body Weight of Padjadjaran Rams

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Abstract

Background and Objective: Sweet orange (*Citrus sinensis*) being an environmental threat and having many dietary beneficial effects, it could be used in the diet of livestock. Therefore, the present study was conducted with the objective to study the effect of dietary inclusion of *Citrus sinensis* waste on Padjadjaran sheep. **Materials and Methods:** This study used 20 Padjadjaran rams with average body weight of 30.42±4.50 kg. The rams were divided into 4 treatments of 5 animals. The sweet orange waste was used at the rate of 0% (control group-R0), 12% (R1), 17% (R2) and 22% (R3). The parameters estimated were crude protein digestibility, initial body weight, final body weight, body weight increase and crude protein of feed. **Results:** The results indicated that the dietary inclusion of sweet orange waste had no significant (p>0.05) effect on the crude protein digestibility of rams when compared with the control group. However, the highest crude protein digestibility (55.26±13.27%) was observed in the group wherein diet of rams was supplemented with 12% sweet orange waste (R2), followed by (53.40±9.04%) the control group. Further, there was no significant (p>0.05) effect on the body weight of rams fed various levels of sweet orange waste when compared with the control group. Highest body weight (0.63±0.94) was found in the control group, followed by (0.59±0.67) R3 group (fed 22% sweet orange waste in the diet). **Conclusion:** The inclusion of sweet orange waste up to 22% in the diet had no negative effect in terms of crude protein digestibility and body weight increase of Padjadjaran rams.

Key words: Sweet orange, waste, diet, protein digestibility, Padjadjaran ram

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Citrus is botanically a large family whose dominant members include sweet orange (*Citrus sinensis*), tangerine orange (*Citrus reticulata*) and grape fruit (*Citrus paradisi*)[1]. Sweet orange is grown in more than 125 countries and its worldwide production has increased from 24 million tonnes in 1961 to 71 million tonnes in 1990[2]. Its production in Indonesia reached 23,55,550 t/year in 2009[3]. The orange fruits represented the 63% of the world citrus production. Citrus fruits contain nitrogen (1-2 g kg^{-1} on a wet basis), lipids (oleic, linoleic, linolenic, palmitic, stearic acids, glycerol and a phytosterol), sugars (glucose, fructose, sucrose), acids (primarily citric and malic), insoluble carbohydrates (cellulose, pectin) and enzymes (pectin esterase, phosphatase, peroxidase). Besides, they are rich in flavonoids (hesperidin, naringin), bitter principles (limonin, isolimonin), peel oil (d-limonene), volatile constituents (alcohols, aldehydes, ketones, esters, hydrocarbons, acids), pigments (carotenes, xanthophylls), vitamins (ascorbic acid, vitamin B complex, carotenoids) and minerals, primarily calcium and potassium[4]. During orange juice production, great amounts of residue (peel, pulp, seeds, orange leaves and whole orange fruits that do not reach the quality requirements) are generated as waste. This waste is generally available in large quantities during the citrus season and thus it may cause an environmental problem since it does not have any productive use. Rather than discarding the orange wastes, they can be sun-dried and then milled in grinding machine to fine particle to obtain the orange waste meal which can be included in livestock diets[5]. The nutrient composition of citrus waste powder is 90.01% dry matter, 6.50% crude protein, 12.76% crude fiber, 3.40% crude fat and 7.70% ash[6].

Padjadjaran sheep is a local genetic material, still in the breeding process for meat and have white hair and wide ears as their identity[7]. They have high potential as meat source and are highly adaptive. In West Java province of Indonesia, the sheep is the fourth meat contributor after poultry, cattle and swine contributes 16.12% to national meat production with population of 59.52% [3]. There is a trend to modify the animal cholesterol and fat content in order to produce high quality products. Consuming such products has been reported to lower risk of obesity, cancer, diabetes and cardiovascular diseases[8,9].

Since, *Citrus sinensis* waste has many benefits and in order to reduce the environmental threat, it could be used in the diet of livestock. Therefore, the present study was conducted with the objective to study the effect of dietary inclusion of *Citrus sinensis* waste on Padjadjaran sheep.

MATERIALS AND METHODS

Study animals and treatments: This experimental study used 20 Padjadjaran rams with average body weight of 30.42±4.50 kg. The rams were obtained from the breeding station of Animal Husbandry Faculty, Universitas Padjadjaran.

Feed used in the study consisted of concentrated ration 40% and *Brachiaria brizantha* grass 60%. The forage was given twice a day, in the morning and afternoon at the rate of 2.8-3.0 kg or on an average 2.825 kg/head/day. The composition of concentrate ration in various treatments have been given in Table 1 and 2. It was fed at the rate of 300 g/head/day. The rams were divided into 4 treatments of 5 animals. The sweet orange waste was used at the rate of 0% (control group-R0), 12% (R1), 17% (R2) and 22% (R3). The nutrient composition of experimental diet was calculated as described by Winfeed[10].

Collection and processing of sweet orange waste: *Citrus sinensis* waste was collected from some restaurants around Bandung city. The collected waste was sun dried and oven dried at 50°C until its water content reached 8%. Afterwards, it was ground in order to obtain its powder form, which was then used in the diet.

Parameters estimated

Nutrient digestibility: Digestibility of feed ration was done in two phases, i.e., initial phase and collection phase.

Table 1: Ingredient composition of various diets

Feed stuff	R0 (%)	R1 (%)	R2 (%)	R3 (%)
Rice bran	28.76	28.42	28.55	28.68
Dried cassava powder	1.00	1.35	1.23	1.10
Spent bean curd	13.13	8.11	6.57	5.02
Citrus sinensis	0.00	12.00	17.00	22.00
Copra meal	3.00	3.00	3.00	3.00
Molasses	22.50	23.97	24.26	24.54
Pollard	26.61	18.16	14.40	10.65
Tapioca waste	5.00	5.00	5.00	5.00
Total	100.00	100.00	100.00	100.00

Table 2: Nutrient composition of various diets

Nutrient content	R0 (%)	R1 (%)	R2 (%)	R3 (%)
Dry matter	85.157	85.848	86.305	86.766
Ash	7.569	7.937	8.134	8.331
Crude protein	12.00	12.00	12.00	12.00
Crude fiber	10.955	11.205	11.312	11.419
Crude fat	5.004	4.903	4.903	4.904
Nitrogen free extract	51.753	52.309	52.435	52.561
Total digestible nutrient	73.00	73.00	73.00	73.00

The initial phase was consisted of 7-10 days. The ration was given twice a day at 08.30 and 15.30 West Indonesian Time (WIT). The objective of this initial phase was to familiarize the ram to the ration and the surroundings[12]. Drinking water was provided after the ram were fed with ration in the excessive (*ad libitum*) scheme. Consumption of the ration was worked out every day by subtracting the ration consumption with ration remnant.

Collection phase and data collection were done in the period of 5-15 days after preliminary phase finished. In this period, ration consumption and feces were measured. Collecting, weighing and recording of excreted feces were done in 7 days. According to Tillman[12] collection phase should be completed in 5-15 days. The procedures of collection phase and data collection were as follows:

- Weighing the ram that will be used in feed digestibility experiment
- Feeding the ram with the ration twice a day at 08.30 and 15.30 WIT. Excessive drinking water to be provided after ration feeding before forage feeding
- Recording ration consumption and feces production every day
- Collecting feces at 07.00 WIT from stall 1 to stall 20, respectively and put into separate plastic bag. The collected feces then weighed and sprayed with 5% boric acid (H_3BO_3) to fix nitrogen so that it will not get converted into NH_3 gas
- Weighing and oven drying of collected feces every day. After being dried, the feces to be weighed again. Finally, 10% out of the collected feces to be used in crude protein digestibility in the laboratory
- Feed digestibility (*in vivo*) was calculated using the following equation as per Vansoest and Robertson[13]:

$$\text{Crude protein digestibility} = \frac{\text{KPK} - \text{FPK}}{\text{KPK}} \times 100$$

Where:

KPK = Crude protein consumption (g)

FPK = Crude protein fraction in feces (g)

Other parameters calculated were:

- Initial body weight
- Final body weight
- Body weight increase
- Crude protein consumption of feed

Statistical analysis: Data collected were subjected to one-way analysis of variance (ANOVA) as per Steel and Torrie[14] and Duncan's multiple range test[15] was used to test the significance of difference between means considered significant at $p<0.05$.

RESULTS AND DISCUSSION

The crude protein digestibility of various treatment groups is given in Table 3. The results indicated that the dietary inclusion of sweet orange waste had no significant effect on the crude protein digestibility of rams when compared with the control group. However, the highest crude protein digestibility (55.26±13.27%) was observed in the group wherein diet of rams was supplemented with 12% sweet orange waste (R2), followed by 53.40±9.04% in the control group. This indicates that the incorporation of sweet orange waste in the diet of sheep did not have negative effect on crude protein digestibility. Presence of saponins and tannins in sweet orange waste[16] has been reported to influence the crude protein digestibility by reducing protein degradation in the rumen and in turn improving post-rumen protein availability. Bampidis and Robinson[17] also reported that the presence of tannin and saponin lowers the solubility of proteins entering the abomasums and small intestine for digestion.

The ration's crude protein conmsuption was also calculated and presented in Table 3. There was no significant effect on the crude protein conmsuption of rams as a result of dietary inclusion of sweet orange waste at various levels. The crude protein conmsuption of ration decreased, though non-significantly in all the groups fed various levels of sweet orange waste in the diet when compared with the control. Further, Table 3 shows the increase in the body weight of rams

Table 3: Effect of dietary sweet orange waste on crude protein digestibility and body weight of rams

Parameters	R0 (%)	R1 (%)	R2 (%)	R3 (%)
Crude protein digestibility (%)	53.40±9.04	55.26±13.27	48.03±10.37	52.86±8.87
Initial body weight (kg)	31.56±5.34	32.40±2.92	31.34±4.06	31.04±5.16
Final body weight (kg)	33.62±6.42	33.58±4.25	32.28±5.29	32.56±6.93
Ration's crude protein consumption (g)	1096.51±239.60	1040.27±133.81	1015.17±161.85	1023.41±244.03
Body weight increase (kg/week)	0.63±0.94	0.53±0.59	0.57±0.80	0.59±0.67

Calculation based on Winfeed[10], Animal requirement based on Kearl[11] fed sweet orange waste in the diet. There was no significant effect on the increase in body weight of rams fed various levels of sweet orange waste when compared with the control group. Highest body weight increase (0.63±0.94) was found in the control group, followed by 0.59±0.67 in the group fed 22% sweet orange waste in the diet (R3). The increase in the body weight was depressed, though non-significantly in all the groups fed various levels of sweet orange waste in the diet when compared with the control.

CONCLUSION

It can be concluded that the inclusion of sweet orange waste up to 22% in the diet had no negative effect in terms of crude protein digestibility and body weight increase of Padjadjaran rams. The sweet orange waste could thus be recommended of inclusion in the diet of rams from economics and environmental point of view.

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