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Effect of Cull Potato (Solanum tuberosum) Feeding at Different Levels on Growth Performance and Physiological Parameters in Thari Male Goat Kids under an Intensive Management System

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Abstract

Market-related organic waste comprises around 5% of the city-wide overall waste. Vegetables are produced in a surplus, which makes them a possible source of pollution. According to a prior study, vegetable waste from a marketplace had a nutritional value that suggested it might be suitable as an alternative for animal feed. This study evaluated the use of cull potatoes as feedstuff for the ration of fattening kids, with an emphasis on body weight gain. Cull potato was included in 0, 5, and 10% of the ration. For this purpose, twelve male goat kids, aged approximately six months, age was determined via dental formula (Schoenian, 2010), with an average body weight of 10±0.31 kg, were selected and divided into three equal groups and randomly assigned to the control and two treatment ration containing cull potatoes. Statistical differences in weight gain per kg of eaten concentrate or concentrate intake were recorded between the group fed cull potato and the control group. These results showed that cull potato can be used as a dietary ingredient for body weight gain. The average final body length, body height, heart circumference, and body weight of male goat kids were found to be significantly ($P<0.05$) greater in groups A and B than in group C. It was determined that because group B is more cost-effective than groups A and C, they benefited more from the male goat kids. The growth performance of goat offspring can be efficiently supported by cull potato feed, as this study shows, especially when mixed with inferior green feeds like maize. According to the research, cull potato forage is a cost-effective source of nitrogen to improve kids ration, with the potential to produce feed that is both economical and high-quality without risking animal performance or health and the primary effect of these findings is the alternative that is produced for improving the environment.

Keywords: Cull potato feeding, body performance, physiological parameters, Intensive management, male goat kids.

Introduction

The goat breeds of Pakistan have great potential to dominate international meat production; e.g., Kamori, Pateri, Tapri, Teddy, Beetal, and Dera Din Panah are popular goat breeds. While Barberi, Chappar, Pak Angora, Bikaneri, Kagan, Khurrasani, Nichi, Kachhan, Thari etc., are also reared in different areas of the country. Goat meat, milk, and dairy products have been transformed because these products are important for financial reasons, and the skin has less significance (Sen et al., 2004). For Pakistani rural farmers, small ruminants are their main source of income.In particular, due to excellent export potential and foreign exchange. There are a number of factors that influence goat production and breeding, including weather, feeding, management, and so on, that should be carefully managed for the purpose of enhancing genetic values and accurately assessing genetic parameters (Getachew et al., 2018; Mustefa et al., 2019). Small ruminants are mostly kept for their milk, with meat with skin being a rare exception. Goats convert roughages into milk,

meat, and skin, which adds to food production, rural employment, and the gross national product. Goats are often kept in small to medium-sized herds, either inside or outdoors, as part of a larger agricultural enterprise. The transhuman herding system, which is also called the nomadic system or extensive production system, is prevalent in the Thar Desert and Kohistan regions. It is mostly dependent on natural rangelands as a source of food, especially during the winter and spring seasons (Sahlu et al., 2009).

Ruminant animals' intake and productivity are primarily determined by the amount and quality of feed they receive (Mertens et al., 1994). Roughages, which are typically preserved (as hay or silage), and concentrate feeds (corn and soybean meal) make up the ruminant diet in feedlot systems. These animals need to be fed diets that are sufficiently balanced in order to meet their nutritional needs and produce the desired results. According to Kumari et al. (2013), two-thirds of the world's population inhabits semi-arid tropical regions where farm animals are the main source of income for those who live in rural areas. The growing population and shifting dietary preferences of people are driving up demand for livestock products like meat and milk. Although Pakistan has very high-quality animals, most of them are underfed and in very poor condition. Because of the low per-acre yield and the 2% decline in the area planted to fodder crops each decade, the amount of fodder produced is 50–60% less than what the animals actually require (Sarwar et al., 2002). The cost of fertilizer for grass growth, as well as adverse weather conditions, may raise the cost of animal feed. As a consequence, food waste can be used as a resource for providing feed ingredients to livestock. This can save expenditure on feed and disposal while also eliminating pollutants (Rivin et al., 2012). For livestock feed, food waste has more nutritional value (Myer & Johnson, 2008). Livestock products are becoming more expensive due to an increase in demand. Unconventional feed sources are crucial for livestock, though, since feed (green grass) shortages are the primary problem.

Numerous industries that process fruits and vegetables produce a vast amount of waste. These non-traditional resources are an excellent approach to providing animals nutrients (Wadhwa & Bakshi, 2013). One of the most prevalent food wastes that can be converted into an alternative animal feed is potato peel, which has low protein levels and renewable sources of fiber (Ncobela et al., 2017). Therefore, it is essential to use food waste materials as leftover waste as feed additives and ingredients. Wastes have usually been fed to animals without being processed for a long time. Potatoes are cultivated in over 100 countries around the world. The potato is known as "the king of vegetables" (Bhajantri, 2011). Potato waste is a rich source of energy for animal production. It has analogous calorie values to barley and corn but is lower in calcium and protein. Moisture is the most difficult situation to deal with when dealing with potato wastage, as the moisture level of potatoes can reach approximately 80%. Most feedlot feeds contain silage, which can provide 45 to 65 percent of the water required. Potato waste contains varying amounts of water, ranging from 72 to 83 percent (Murphy, 1997). The main purpose of potatoes is to provide energy. They contain between 82 and 83 percent total digestible nutrients, which conveys to about 10 percent protein on a 100 percent (DM) basis. According to Boyles (2000), only 60% of the crude protein is digestible. Potatoes should be viewed as a highly hydrated store of starch rather than as a forage alternative due to their low fiber content. Given their relatively low protein content, potatoes will provide average growth performance or feed conversion efficiency if fed in excess without protein supplements.

When used as a replacement for concentrate feed mixtures, potato waste at a 25% dry matter level significantly improved dry matter digestibility and nitrogen balance (Gado et al., 1998). According to Omer and Tawila (2008), substituting potato by-products for yellow corn reduced the amount of yellow corn used in the goat ration by 50% while maintaining goat performance. Increased concentrate content in lamb rations contributes to raising the rate of weight gain (Kumari et al., 2013; Malisetty et al., 2014; Basso et al., 2018). While it has been demonstrated

that concentrates may enhance animal performance, it is believed that performance may also be impacted by the use of varying concentration ratios in combination with either dry (hay) or moist (silage) roughages. The animal's intake pattern and, consequently, performance may be changed by the variation in roughage density and the different amounts of concentrate in the ration. Based on this, it is thought that animals may gain weight at the trough if they prefer dry roughage to moist roughage.

When used as a replacement for concentrate feed mixtures, potato waste at a 25% dry matter level significantly improved dry matter digestibility and nitrogen balance (Gado et al., 1998). Omer and Tawila (2008) found that by substituting potato by-products for yellow corn, the amount of yellow corn in the goat ration was reduced in half without compromising goat performance.

Significant features

This study was conducted in light of the aforementioned in order to assess the effects on the growth performance and physiological status of feedlot kids of different levels of cull potato (Solanum tuberosum) and roughage (green grass), combined with a constant level of concentrate feed (Master Feed).

Materials and Methods

The Livestock Experimental Station, Faculty of Animal Husbandry and Veterinary Science, Sindh Agriculture University Tandojam, Pakistan, is where the current study was carried out.

Materials

Animals (twelve healthy male goat kids (weaned) were brought), Weighing balance (weight was taken by a weighing machine made by the "Yemeto" Company in China), Mangers (Plastic tubes were used for feeding kids.) Water trough, tags (plastic numbered pieces were used for identification) Jute threads (used for hanging tags in the neck region), Measuring tapes (measuring tape was used to measure body parameters, e.g., body length, body height, and chest girth), mercury thermometer (used for take rectal temperature), stethoscope/stopwatch (to record the frequency of the heart rate).

Animals and experimental design

For the experiment, it was preferable to use twelve male goat kids of the same age who had been aged about six months. Each group's first twelve days were allotted to adaptation. Before beginning experimental feeding, kids are raised in confined, well-ventilated animal sheds. Using plastic tags, each kid was assigned a distinctive recognition number during the adaptation period. Ivermectin and albendazole medications were used to treat both internal and external parasites. They showed no symptoms of external injury or clinical illness and were in good health. Three groups of four male goat kids each were formed: Group A (Control) was fed green fodder (maize) and a concentrated ration. Group B (Treatment) acquired a concentrated ration and green fodder (maize) with 5% cull potato. Group C (Treatment) was fed a concentrated ration, green fodder (maize) with 10% cull potato. At the livestock experimental station, each group was raised under an intensive management system (Table 1). Nevertheless, water was available to all animals at all times.

Table 1: Experimental design

Groups	A (control)	B (treatment)	C (treatment)
No. of Animals	04	04	04
Cull potato	0%	5%	10%
Roughage	Maize	Maize	Maize
Concentrate	Master feed	Master feed	Master feed
System	Intensive management	Intensive management	Intensive management

Table 2: Chemical composition of cull potato

Feed	DM%	C. Protein%	C. Fiber%	C. Fat%	NFE%	T. Carb.%	TDN%	Ash%
Potato	19.03	1.093	12.45	2.25			77	4.03

DM=Dry Matter, **C**=Crude, **NFE**= Nitrogen Free Extract, **TDN**= Total Digestible Nutrients

During the experiment, the following parameters were recorded:

Body performance

After 12 days of adaptation, the body conformation was measured initial, weekly, and final measurements with a measuring tape (in centimeters). Three body conformations were measured: body height at wither (distance between the highest position at wither and the floor/platform surface), heart girth (circumference of the animal's body just behind the forelegs), and body length (distance between the point of shoulder and pin bone). Initial, weekly, and final measurements were made of the animal's body weight using a weighing machine (Yameto, China).

Physiological parameter

Pulse rate (beat/minute) a stopwatch was used to record the frequency of the heart rate with a stethoscope. Respiration rate (breath/minute) was (physically inspected) or examined using a stethoscope and a timer to count the frequency of flank movement per minute. Rectal temperature (^{0}F) of the male goat kids was monitored using a mercury thermometer. The animals were gently handled and a thermometer probe was inserted 5 cm into the rectum, in the contact of rectum's wall for two minutes. Overall parameter monitored 8:30 am in the morning and 6:30 pm in the evening, once time in a week.

Statistical analysis

A statistic al analysis (Statistix 8.1) was used to do an analysis of variance on the collected data to find out if there were any significant differences between the three different groups. LSD (least significant difference) and SE (standard error) tests were also required to evaluate the level of significance between group mean values.

Results and discussion

The purpose of this study was to test the hypothesis that cull potato from marketplace could be used as a dietary ingredient for fattening in kids. In general, treatment diets including cull potato were successful in ensuring weight gain and concentrate intake that are similar to that used in the control diet.

Growth performance

Table (3) demonstrates the growth performance results of male goat kids under the intensive management system. Groups A and B did not differ significantly ($P < 0.05$), but group C did differ significantly ($P < 0.05$) in terms of final live body weight, total live body weight gain, and average daily gain up to nine months of age, respectively. The provision of 2.5% concentrate with maize fodder and 2% concentrate with maize fodder and 5% cull potato in diets is what caused the superior growth performance of kids in groups A and B. At the same time, the relatively lower weight gain of kids in group C suggests that a 1.5% concentrate with maize fodder and more cull potato (10%) in diets is what caused the lower weight gain of kids in group C. The similar findings were recorded by Aregheore (2004). The mixed diets resulted in significantly higher ($P < 0.05$) consumption compared to just sweet potato or batiki grass diets, and the goats gained significantly ($P < 0.05$) more live weight. Lam and Ledin (2004) observed that with adequate live weight improvements (60.9 g/day), half of the Sesames grandiflora can be substituted with fresh sweet potato vines. Semenye and Hutchcroft (1992) found that when goats were fed 30 g DM per kilogram of body weight per day, sweet potato vines satisfied their needs. Similarly, supplementing young bulls fed sugarcane stems with sweet potato fodder increases feed intake and weight gain (Dominguez, 1992), and the ideal weight gain for Arsi-Bale goats raised on grazing and browsing alone was 7.94 g per day (Kebede et al., 2011). According to Elkhider (1989), sweet potato vine consumption was higher than that of Clitoria and Berseem, but lower than that of Malavanh and Preston (2006). Group B had the largest fodder intake compared to groups A and C, which is in line with the report by Abonyi et al., (2012). The weight gain in this experiment was more than that reported by Aregheore (2007) and Kebede et al. (2008), and the feed conversion performance in this experiment was equivalent to the result found by Lam and Ledin (2004) but less than the findings that Abonyi et al. (2012) reported. The findings of the current research do not agree with those obtained by Omer et al., (2011). The findings showed that while feed conversion, measured as kilogram consumption of DM per kilogram gain, decreased insignificantly, increasing the amount of PPW in the treatment rations had a significant ($P>0.05$) impact on final weight, body weight gain, average daily gain (ADG), and relative gain. According to Omer et al. (2010), when sheep were fed a ration supplemented with PPW, 25% or 50% of the basal diet's yellow corn was substituted. Sauter et al. (1980) discovered that including 50% potato by-product in barley-based diets caused a 17% decrease in ADG and a 5% decrease in efficiency when compared to 25% potato by-product. Also, Radunz et al. (2003) found that when added to enriched beef cattle finishing diets, PPW from frozen potato industry products raised ADG and feed efficiency from 0% to 30% and then to 40% (quadratic, $P<0.01$).

Table 3: Growth performance of Male Goat Kids fed diets containing varying levels of cull potato

Parameter (%)	Inclusion level with cull potato (%)			LSD (0.05)	SE
	0	5	10		
Average initial weight (kg)	10.266	10.061	10.012		
Average final weight (kg)	16.717	15.808	14.317	1.9771	0.9980
Average weight gain (kg)	6.451	5.747	4.305		
Average daily weight gain (gm)	68	62	48		

Physiological Parameters

One of the most important physiological parameters of kids was evaluated under an intensive management system that offered cull potato as a supplement with different levels (5 and 10%), along with a concentration ration and green grass. The results are presented in Table 4. However, the obtained result of the physiological parameter of male goat kids showed the groups did not differ significantly ($P < 0.05$) and were within the normal range from the first week up to the last

week of the experiment for the kids. Substitution of green grass and concentrate with cull potatoes in the dietary habits, there was no significant impact of fattening kids on any of their physiological parameters. The effect of potato vines on ruminant performance is not well documented in the literature. The results of the current study, however, support earlier findings that ruminants may be fed processed potato leaves without suffering any adverse health effects. Regarding this, Parfitt et al. (1982) found that goats' health was unaffected by feeding them potato vine silages that contained 88–295 mg of total glycoalkaloids per 100 g DM (as measured in fresh vines). Likewise, no symptoms of poisoning were observed in sheep fed potato vines ensiled with 5% barley or 20% chopped hay, containing 32 and 23 mg total glycoalkaloid/100 g DM, respectively (Nicholson et al., 1978). Dijkstra (1945) found no poisoning in sheep and cattle fed potato vine silage, which is in line with our findings. Since rumen microbes convert potato glycoalkaloids to solanidine, a less toxic substance, they pose less of a threat to ruminants. However, the majority of researchers found that oral administration of potato glycoalkaloids or potato leaves had no negative effects on animal health (Nishie et al., 1971; Dalvi, 1985; Phillips et al., 1996), suggesting that oral administration of glycoalkaloids has a less toxic effect than other forms of administration. 14 This is mostly because animals' gastrointestinal tracts only absorb a small amount of glycoalkaloids (Nishie et al., 1971). The glycoalkaloid content is the main issue with using potato vines as animal feed (Morris and Lee, 1984). It has been demonstrated that ensiling potato vines lowers their glycoalkaloid content (Nicholson et al. 1978). There is no harm to the health of dairy and beef cows if they consume up to 15–20 kg of raw potatoes per day (Fiems et al., 2013). Regarding the breakdown of potato vine glycoalkaloids during drying or decaying, no information is available. Nonetheless, our earlier research (unpublished data) showed that letting potato vines dry in the shade reduced their α-solanine content by 32% (17 mg/100 g DM in shade-dried vines versus 25.2 mg/100 g DM in fresh potato vines). According to the findings, fattening lambs can be fed processed potato vines without suffering any adverse effects on their performance or health (Malecky et al., 2017). As a result, it can be concluded that cull potatoes can be fed to ruminants without negatively impacting their performance by up to 10%.

Conclusions

The study's findings suggest that male goat kids can gain weight from feed cull potatoes as a feed ingredient. Monitoring the cull potatoes' quality and the animals' dry matter intake is crucial to ensuring the best essential animal performance. Given their limited utility for human consumption and low industrial value, cull potatoes provide a cost-effective substitute for conventional feed ingredients in kid's rations. The ideal quantity of cull potatoes to include in the ration for kids depends on a number of aspects, such as the cost of transportation and the cost of other food items used to make the ration. Treatment groups B and C showed lower values than the control group (Group A) in terms of feeding cost and relative economic efficiency, indicating the financial benefit of using cull potatoes up to 5% in the ration. Furthermore, kids' growth performance, nutrient digestibility, total digestible nutrient (TDN) levels, and energy utilization were all improved by supplementing with cull potatoes. Compared to Groups A and C, these improvements were most noticeable in Group B, which demonstrated better outcomes with no negative effects as compared to Group B.

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