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Effect of Dietary Supplementation of Ginger and Garlic Mixture on Performance of Ardi Goats under Stressful Conditions

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ABSTRACT

Background: Among the different range animals, goats can adapt and survive greatly under harsh environmental conditions. The aim of this study was to investigate the effect of using a mixture of garlic and ginger as supplementation to improve the growth performance and nutrient digestibility of Ardi goats.

Methods: A total of twenty Ardi goats (40.35±1.8 kg) were assigned randomly into four experimental groups. The first group received a basal diet (control), the second to fourth groups were dietary supplemented with a mixture of garlic and ginger at the different levels of 20, 40, and 60 g/animal/day, respectively for 12 weeks.

Result: There were no significant differences in the final body weight and feed conversion ratio of goats fed different levels of dietary supplemented of ginger and garlic mixture. The TDMI and daily DMI significantly reduced in groups fed diets supplemented with 20 and 40 g/animal/day than the control group. The digestion coefficients of CP, fiber fraction digestibility, and TDN values decreased in different groups. In conclusion, the addition of ginger and garlic mixture at the studied levels did not significantly affect animal performance and had negative impacts on feed utilization and nutrient digestibility.

Key words: Ardi goats, Garlic powder, Ginger powder, Nutrient digestibility, Productive performance.

INTRODUCTION

Goats are preferred to be raised in desert environments, such as Saudi Arabia, because their nutritional needs are lower than those of cattle (Daramola *et al*., 2021; Al-Suwaiegh *et al*., 2020). Goats have a higher capacity to convert low-quality feed into high-quality products with higher economic returns than other animal species (Daramola *et al*., 2021). Due to these benefits of raising goats in harsh environments, the rates of goat productivity are acceptable, and young breeders have a good opportunity to initiate a goat-raising project (Joy *et al*., 2020). Ardi goats are the most important local Saudi Arabian goat breed, characterized by their ability to live and survive in a very harsh environment (Al-Atiyat and Aljumaah, 2014). In order to adapt to unfavorable climatic conditions, optimal nutrition may be necessary to increase animal productivity, particularly in small ruminants with poor genetic potential that are common in dry and semi-arid regions (Joy *et al*., 2020).

The use of herbal plants has recently attracted the attention of many animal producers due to their low cost, low risk, less poisonous, residue-free, more palatable, and greater integrity, which may boost the animal's productivity (Morshedy *et al*., 2021; El-Gindy *et al*., 2021). Herbal plants such as ginger and garlic are widely used in animal nutrition and have been found to possess medicinal properties (Daharia *et al*., 2022). Ginger and garlic have known proven biological effects such as antioxidants properties, anti-bacterial action and anti-inflammatory effects (Panpatil *et al*., 2013). Moreover, garlic and ginger, as natural growth promoters, can improve feed utilization, nutrient digestibility and body physiology, and thus reducing the high feeding cost (Pandey *et al*., 2019).

Zingiber officinale (ginger), a member of the Zingiberaceae family, is a rhizome plant that has been used as a spice in cooking throughout the world and as a therapeutic herb for a very long time (Daharia *et al*., 2022). Ginger is rich in gingerols, shogaols and paradols, which are the main active phytochemicals that have strong antioxidant and chemopreventive properties (Panpatil *et al*., 2013). Ginger essential oil contains several terpene components, such as β-bisabolene, α-curcumene, zingiberene, α-farnesene, and β-sesquiphellandrene (Elazab *et al*., 2022).

Garlic (*Allium sativum*), a member of the family Liliaceae, is a widely consumed spice in the world and has an abundance of bioactive constituents (Shang *et al*., 2019). Among the bioactive substances found in garlic are organosulfur compounds, polyphenols, saponins, fructans,

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and fructooligosaccharides (Chandran *et al*., 2022). Moreover, organosulfur compounds found in garlic include allicin, alliin, diallyl sulfide, diallyl disulfide, diallyl trisulfide, ajoene and S-allyl-cysteine (Shang *et al*., 2019). The physiological benefits of ginger and garlic include antioxidant, antimicrobial, immunostimulatory, among other properties (Panpatil *et al*., 2013; Chandran *et al*., 2022). The aim of this study was to investigate whether dietary supplementation of a mixture of garlic and ginger (1:1) at different levels could alleviated the drastic effects of harsh conditions on the animal performance, feed utilization and nutrient digestibility of Ardi goats.

MATERIALS AND METHODS

Animals, experimental design, and housing environment

The trial was conducted at the Research and Training Station at King Faisal University in Al-Ahsa, Saudi Arabia from August to October 2021. Saudi Arabia at this time of the year is characterized by high temperature and low humidity.

A total of twenty Ardi goats, aged, with an average body weight of 40.35 ± 1.8 kg were used in this experiment. Goats were randomly divided into four groups (n= 5); this was the bare minimum number of goats required to test the hypotheses to maximize the scientific benefit, without compromising the experiment's objectives or the statistical power required to adhere to the 3Rs protocol (Liu *et al*., 2020). The 1st group received a basal diet (T1) The 2nd to 4th groups were dietary supplemented with a mixture of garlic and ginger powder (1:1) at the doses of 20, 40, and 60 g/ animal/day (T2, T3, T4), respectively. Each animal was individually kept in crate located under a semi-shade provided with feed manager and water source. The experiment lasted for 12 weeks. Vaccinations against the main diseases and deworming as of Veterinary Sector Guidance, Ministry of Environment Water and Agriculture, Saudi Arabia were administered to all animals before the beginning of the experiment.

Experimental diet

The basal ration was formulated and offered to meet the nutrient requirements of growing goats according to (NRC, 2007). The total mixed ration consisted of 50% alfalfa hay and 50% concentrate mixtures as are shown in Table 1. The diet was offered ad-libitum once daily at 8.00 a.m., and the refusals were recorded daily to determine feed intake. Daily feed intake (FI) was individually recorded throughout the whole experimental period, as the difference between the offered and refused feed. Mineral blocks and clean drinking water were available to goats all the time Goats were individually weighed every two weeks before the feeding time for 12 weeks. Using a digital balance, the initial and final body weights (BW) were recorded. The difference between the final and initial body weights (BW) was used to compute the body weight gain (BWG), and the average daily gain (ADG) was calculated as BWG divided by the number of days throughout the trial period (84 days). The feed conversion (FCR) ratio was calculated by dividing average feed intake/average weight gain.

Digestibility trial

Twenty Ardi goats were individually adapted to the metabolic cages for one week, followed by 10 days as the collection period. Growing goats were randomly allocated into four equal groups (3 goats each). The control group were fed a basal diet without any supplementation. The other three groups were fed the basal diet supplemented with a mixture of garlic and ginger powder at doses 20, 40 and 60 mg/ animal/day. T1 (control no feed additive), T2 (20 gm of garlic and ginger mixture), T3 (40 gm of garlic and ginger mixture), and T4 (60 gm of garlic and ginger mixture). Samples of refused feed and fecal output were recoded daily before offering the morning meal during the collection period. Approximately 10% of the daily feces of each animal were sub-sampled, well mixed, and kept at -4°C until chemical analysis. Apparent digestibility coefficients for each nutrient were calculated by expressing the weight of each nutrient absorbed as a proportion of the weight consumed (nutrients consumed in feces/nutrients consumed). Nutritive values in terms of total digestible nutrients (TDN) and digestible crude protein (DCP) were calculated according to the classic formula of NRC (2001) as follows:

$$TDN\% = DCP\% + DCF\% + DNFE\% + (DEE\% \times 2.25)$$

Where
DCP= Digestible crude protein.
DCF= Digestible crude fiber.
DNFE= Digestible nitrogen-free extract.
DEE= Digestible ether extract.

Proximate analysis of feed and feces

Samples of the experimental basal total mixed ration and feces were collected and dried in a forced-air oven at 65°C for 72 h to calculate the dry matter intake. The proximate analysis was conducted according to AOAC (2006). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were determined without using sodium sulfite or α-amylase according to Van Soest and Robertson (1985).

Statistical analysis

The data obtained from the experiment were subjected to one-way analysis of variance (ANOVA) and were expressed as means with a standard error of mean (Mean ± SEM) using SPSS for Windows, Version 16.0. Chicago, SPSS Inc. Treatment means were separated (p <0.05) using Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Animal performance

The effects of dietary supplementation with a mixture of garlic and ginger powder at different levels on goat performance are shown in Table 2. There was no significant difference in the final body weight of goats fed diets with different levels of a mixture of ginger and garlic powder. The total body

weight gain and ADG were not affected by dietary supplementation with a mixture of garlic and ginger powder. However, ADG differed significantly among different weeks (2nd, 7th, 11th weeks) as presented in Fig 1 A. Similarly, garlic powder supplementation up to 1.5% in diet did not affect the final weight and ADG of West African Dwarf goats (Ikyume *et al*., 2017). In contrast with the present results, the addition of 2 g of dried garlic improved body weight gain in growing male buffaloes (Hassan and Abdel-Raheem, 2013). According to Zhong *et al*. (2019), feeding lambs garlic powder improved growth performance as well as animal health. In addition, ADG improved in rabbits fed garlic-based diets (Onu and Aja, 2011) or fed ginger powder-based diets (Ogbuewu *et al*., 2017). On the other hand, ADG was reduced in rabbits fed garlic powder at 0.25% and 0.5% (Hossain *et al*., 2015).

Table 1: Ingredients and the proximate analysis of the experimental total mixed ration.

Ingredients of the total mixed ration	g/kg DM
Alfalfa hay	500.00
Wheat bran	147.00
Barley	307.00
Soybean meal	7.50
Dicalcium phosphate	10.00
Limestone	20.00
Salt	6.10
Vitamin and mineral premix[1]	2.40
Proximate analysis of the total mixed ration	**g/kg DM**
Dry matter	888.00
Organic matter	935.00
Crude protein	146.00
Ether Extract	25.00
Ash	65.00
Crude fiber	195.00
Neutral detergent fiber	539.00
Acid detergent fiber	343.00
Non-fiber carbohydrates	225.00
Hemicellulose	196.00
Calcium	17.00
Total phosphorus	5.60
Total digestible nutrients	625.00

The TDMI and daily DMI were significantly lower (P<0.05) in groups supplemented with a mixture of garlic and ginger powder at doses of 20 and 40 g/animal/day than the control group (Table 2). However, there was no difference in TDMI and daily DMI among supplemented. There were significant differences in daily DMI among different weeks (Fig 1 C). The dietary supplementation with a mixture of garlic and ginger powder did not affect DMI%, BW, and FCR. There were significant differences in FCR among different weeks (2nd, 7th, 11th weeks), however DMI % BW did differ among experimental weeks (Fig 1 B - D, respectively).

In line with these results, DMI did not affect beef cows fed 40 g/d garlic powder (Wanapat *et al*., 2013). In addition, Bampidis *et al*. (2005) who observed that inclusion of supplemental levels of garlic bulb or husk in the diet of growing lambs had no significant effect on FCR. Contrary to the above findings, FCR improved significantly in male pigs fed dried garlic at 1% and 10% (Cullen *et al*., 2005).

In addition, diets containing 1.5% of ginger root powder significantly improved the FCR of NZW rabbits (Bakr *et al*., 2016). Overall, the reasons for the difference between this study and previous studies could be related to high levels of dietary supplementation with a mixture of garlic and ginger powder as well as differences in animal type and diet composition.

Effect of dietary treatments on nutrient digestibility

The digestion coefficients of dry matter, organic matter, ether extract, and non-fiber carbohydrates did not affect by the different levels of dietary supplementation with a mixture of garlic and ginger powder (Table 3). However, the digestion coefficient of crude protein was significantly decreased by different levels of dietary supplementation with a mixture of garlic and ginger powder. The same trend was observed in the digestion coefficients of the fiber fractions (CF, NDF and ADF).

The values of DCP did not differ among treatments. However, the TDN decreased significantly in the group supplemented with a mixture of garlic and ginger powder at 40 g/animal/day and insignificantly in groups supplemented with 20 and 60 g/animal/day, compared to the control group. In line with the present results, the apparent digestibility of DM, OM, aNDF and ADF were not affected by dietary supplementation with 40 g/d garlic powder, while CP digestibility tended to be decreased in beef cows (Wanapat

Table 2: Effect of dietary supplementation with a mixture of garlic and ginger powder at different levels on goat performance.

Items	T1	T2	T3	T4
Initial BW	37.75±4.43	37.00±4.92	37.50±5.45	38.75±5.45
Final BW	46.13±4.24	45.05±4.72	46.33±5.22	46.38±5.43
TBG (kg)	8.38±0.41	8.05±0.22	8.83±0.25	7.62±0.21
ADG (g/day)	99.70±4.91	95.83±2.67	105.06±3.02	90.77±2.45
TDMI (kg)	116.18±3.37[a]	104.56±1.90[b]	105.06±2.75[b]	111.50±3.18[ab]
Daily DMI (kg)	1.38±0.04[a]	1.25±0.02[b]	1.25±0.03[b]	1.33±0.04[ab]
DMI % BW	3.43±0.35	3.23±0.43	3.26±0.57	3.39±0.54
FCR (TDMI/TBG)	14.05±0.94	13.05±0.55	11.97±0.62	14.66±0.57

Table 3: Effect of dietary supplementation with a mixture of garlic and ginger powder at different levels on digestibility coefficients of Ardi goat diet.

Item (%)	T1	T2	T3	T4
Digestibility coefficients (%)				
Dry matter	70.73±2.06	66.15±2.64	63.88±4.69	69.13±1.23
Organic matter	71.72±1.99	67.29±2.55	65.10±4.53	70.17±1.18
Crude protein	78.66±0.36^{a}	62.63±2.91^{b}	60.13±5.18^{b}	65.93±1.35^{b}
Ether extract	74.42±0.77	69.00±2.42	66.93±4.23	71.73±1.12
Crude fiber	67.46±1.59 ^{a}	45.53±4.25^{b}	41.88±7.55^{b}	50.33±1.98^{b}
Neutral detergent fiber	77.65±1.25^{a}	65.15±2.72^{b}	62.83±4.83^{b}	68.22±1.27^{b}
Acid detergent fiber	69.86±0.68^{a}	60.25±3.10^{b}	57.59±5.51^{b}	63.75±1.44^{b}
Non-fiber carbohydrates	78.02±1.62	74.34±2.07	72.46±3.68	76.81±0.77
Nutritive value (%)				
Digestible crude protein	9.54±0.23	8.74±0.41	8.39±0.72	9.19±0.19
Total digestible nutrients	72.14±1.41^{a}	65.28±2.49^{ab}	63.12±4.42^{b}	68.12±1.11^{ab}

Means in a row without a common superscript letter differ (P<0.05). T1: control, T2-T4: a mixture of garlic and ginger powder at different levels 20, 40, and 60 g/animal/day.

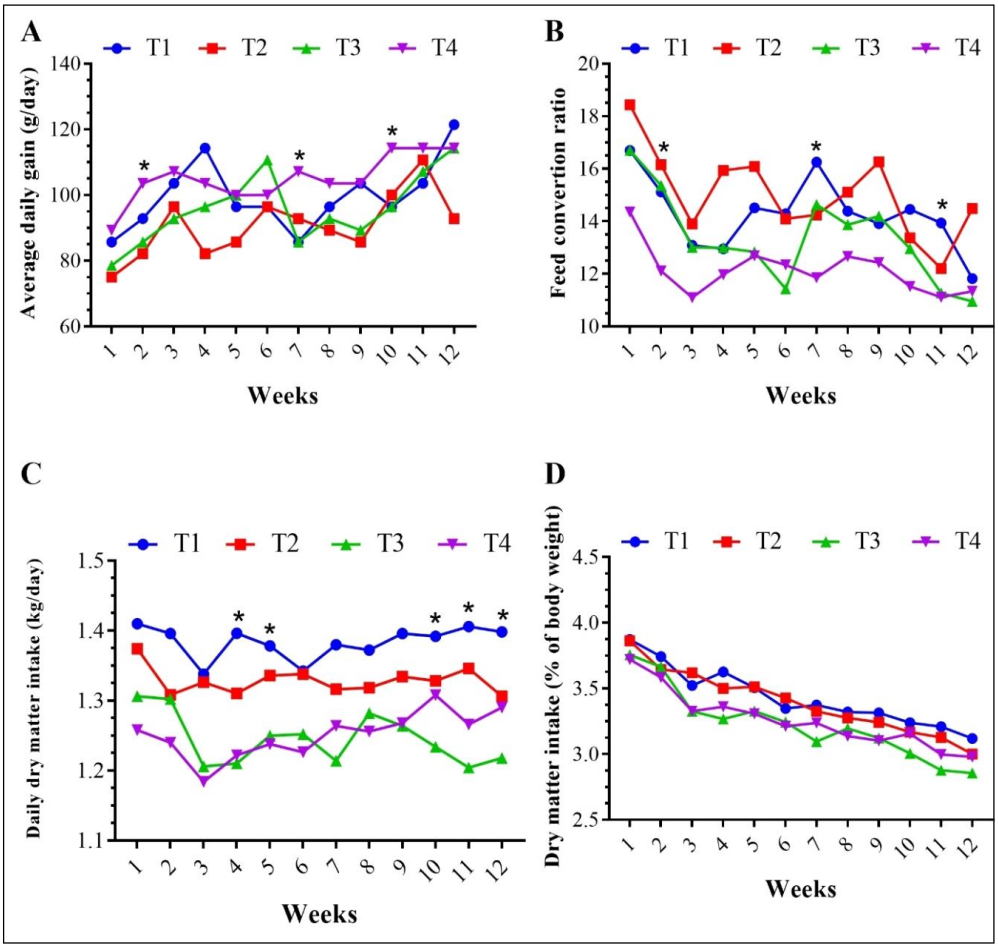

Fig 1: Effect of dietary supplementation with a mixture of garlic and ginger powder at different levels on goat performance during the experimental period. * Means with significant difference at (p<0.05). T1: control, T2-T4: a mixture of garlic and ginger powder at different levels 20, 40 and 60 g/animal/day.

et al., 2013). Additionally, 0.5-1.5% of garlic powder supplementation did not affect the digestion coefficients of DM, CF, EE, Ash, NDF and ADF and decreased CP digestibility in West African Dwarf goats (Ikyume *et al*., 2017). An opposite trend to the present study was observed by Zhong *et al*. (2019), who reported that feeding lambs garlic powder improved feed digestion and rumen fermentation. Moreover, the ginger supplementation significantly improved nutrient digestibility and feed efficiency in multiparous Egyptian buffaloes (Fahim *et al*., 2022).

CONCLUSION

In conclusion, the dietary supplementation of ginger and garlic powder mixture at different levels in goat diets did not significantly improve animal performance. Meanwhile, the dietary ginger and garlic powder mixture significantly reduced crude protein, crude fiber, neutral detergent fiber, and acid detergent fiber digestibility. Also, total digestible nutrients value decreased significantly in group fed 40 g/ animal/day of the supplementation. Lower levels of ginger and garlic powder mixture in the diet of arid goats require further investigation.

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Conflict of interest: None.

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