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Ex-vivo Anaerobic Digestion of Non-Palatable Pastoral Plant Toward Non-traditional Animal Feed

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It is forecasted that by the end of 2025, 2.2 billion tons waste, including the non-palatable plants, will be generated annually. This is a foreseeable concern for the public health and the economy. Accordingly, waste management programs, including for the unused, unacceptable, or unpalatable plants, have been initiated worldwide. The aim of this study was to process an *ex-vivo* anaerobic digestion of the *non-palatable* pastoral plant to produce non-traditional animal feed. Five plants were selected for the present study, namely, *Aerva javanica, Capparis cartilaginea, Ochradenus baccatus, Salvadora persica,* and *Senna alexandrina*. These plants were collected from the endangered pasture from the Al-Baha region of the south west of the Kingdom of Saudi Arabia. The collected plants were shredded into small pieces, and were subjected for the anaerobic digestion at 20°C, 30°C, and 40°C for 90 days. The evaluation of plant acceptability was achieved by observing the animals and the quantity of the digested plant material consumed by the animals. The results of the plant acceptability were very promising with respect to *O. baccatus*, *S. persica* and *S. alexandrina*. Good acceptability upto 100% was observed for the digested material of these plants at all the studied temperatures, 20°C, 30°C, and 40°C. It is concluded that similar studies should be carried out in other regions of the Kingdom of Saudi Arabia at large scale and on alarge number of non palatable pastoral plants.

Keywords: Non-palatable Pastoral Plants, *Ex-vivo* Anaerobic Digestion, Acceptability, Non-traditional Forage, sheep.

Plants are a source of many valuable items for the human being, for example, a source of medicine, and food. However, all the plants cannot be used as a source of medicine or food. The unused plants can be considered as a waste products like other waste products that includes the Municipal Solid Waste. On study forecast that by the end of 2025, 2.2 billion tons waste will be generated annually[1,2], which is foreseeable concern for the public health and the economy. Accordingly, waste management programs, including for the unused plants, have been initiated worldwide[3].

Kingdom Saudi Arabia has also inclined its interest in the waste management with the objective of environmental protection, resources conversion and energy generation[1]. Recent studies have revealed that because of the increased consumption of the meat and the meat products in the Kingdom of Saudi Arabia, number of animals have to be sacrificed [4]. This demand has increased

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the need for the animal breeding. Therefore, overgrazing in the pastures has been detected in the Kingdom of Saudi Arabia, which is further aggravated by the dryness and the low rainfall in the Kingdom[5]. As a result, animal breeders in Saudi Arabia staterted the importation of the green fodder and large amounts of forage, which also caused an economical burden.

Anaerobic digestion is a complex process which involves breaking down the biodegradable material in the presence of anaerobic microorganism. This process is affected by many factors, including the temperature of the anaerobic digestion[6-8]. Many reports have been published, wherein the process of anaerobic digestion has been used for the production of biogas, organic fertilizer, as well as for the resource conversion[9,10]. Accordingly, The Kingdom of Saudi Arabia is also exploring the feasibility of the anaerobic digestion process of the plants for resource conversion[1]. From the literature, it becomes evident that there is a possibility to convert the agriculture waste, including the non-palatable pastoral plants present in the Kingdom to non-traditional palatable pastoral plant material as animal feed. To the best of our knowledge, there is no published research report on this subject. Therefore, the aim of this study was to process an *ex-vivo* fermentation of non-palatable pastoral plant to produce non-traditional animal feed.

MATERIALS AND METHODS

Targeted plants

Five plants were selected for the present study, namely, *Aerva javanica* (Burm.f.) A.L.Juss. ex Shult.;*Capparis cartilaginea* Decne; *Ochradenus baccatus* Delile; *Salvadora persica* L.; and *Senna alexandrina* Mill. These plants were collected from the endangered pasture from the Al-Baha region ofthe south west of the Kingdom of Saudi Arabia during the month of february 2017, and were identified and authenticated by the specialists in Al-Baha university.This animal study was approved by the local ethical committee of the Northern Border University.

Animals

Local sheep, *Ovis aries* L. (Strain Alherri; 15 kg to 25 kg body weight), were selected for the field trials. The available animals, males aged between 6-7 month, and females aged between 22-24 month were included in the study. This study was approved by the Local Committee of Bioethics at the Northern Border University.

Treatment of the Plants

The collected plants were shredded into small pieces of about 5 cm to increase the contact surface area and to facilitate the anaerobic digestion. The shredded plants were supplemented with about 5% (w/w) of the sheep rumen (fluid) content and about 0.2% (w/w) of the 1% sucrose solution in the distilled water at pH of about 6.6 to 6.8 (Jenway-United Kingdom). The purpose of adding sucrose was to activate the anaerobic microorganisms and to accelerate the anaerobic digestion process. The obtained mixture was distributed in the glass jars of 4 liter capacity and then the air was sucked by a vacuum pump (Diaphragm Vacuum Pump-Germany). The jars were incubated (Panasonic-Japan) for 90 days at 20°C, 30°C and 40°C. One jar was also incubated as a control.

Evaluation of the Plant Palatability or Acceptability

At the end of the incubation period; jars were opened and content were aerated for about 30 minutes, and then carried to sheep early in the morning before grazing. The evaluation of palatability was achieved by observing the animals and the quantity of the plant material consumed by the animals. Simialr methods are reported in the literature[11].

RESULTS AND DISCUSSION

The results obtained after the completion of the experiment are provided in the Table1.

The obtained results revealed that the anaerobic digestion of the plant *C. cartilaginea* didn't raise its acceptability as sheep didn't eat the digested plant material. The possible reason for this may be the smell or odor of the digested material. The generation of the smell may the due to the uncontrolled moisture, pH variation, and the inappropriate carbon and nitrogen content during the tenure of the experiment. The chemical constituents of the digested material may be another reason the smell of the digested material. The digested material of *A. javanica* exhibited noticeable acceptability, where in the

digested material obtained after the treatment at 30°C and 40°C showed good acceptability in aged animals. However, the acceptability of the digested material at 20°C was estimated as negative. This may be due to the incomplete digestion of the plant at 20°C, which might be causing repelling smell or odor. The results of the acceptability were very promising with respect to *O. baccatus*, *S. persica* and*S. alexandrina*. Good acceptability was observed for the digested material of these plants at all the studied temperatures, 20°C, 30°C, and 40°C.The good acceptability of the digested materials of *O. baccatus*, *S. persica* and *S. alexandrina* at different temperature also reflects a possibility that these digested materials can be stored at higher temperature for a long period of time, which may affect the possible reduction in the cost of the forage unit. It is recommended that introducing the digested plant in the sheep feed should be gradual, which may provide a sufficient period of adaptation for the animals.

These results also revealed that the digested plant material of *O. baccatus*, *S. persica* and *S. alexandrina* may fill the feed gap in the studied region in which, endangered pasture was noticed due to overgrazing. It is also assumed that

Table 1. Plant palatability or acceptabilityof anaerobic fermented, non-pastoral plants at different temperatures

S. No	Plant	Temperature	Repetition	Plant palatability / acceptability among sheep
1	*Capparis cartilaginea*	20°C	R1, R2, R3	0%*
			C (control)	0%*
		30°C	R1, R2, R3	0%*
			C (control)	0%*
		40°C	R1, R2, R3	0%*
			C (control)	0%*
2	*Aerva javanica*	20°C	R1, R2, R3	> 50% < 100%**
			C (control)	0%*
		30°C	R1, R2, R3	100%***
			C (control)	0%*
		40°C	R1, R2, R3	100%***
			C (control)	0%*
3	*Ochradenus baccatus*	20°C	R1, R2, R3	100%***
			C (control)	0%*
		30°C	R1, R2, R3	100%***
			C (control)	0%*
		40°C	R1, R2, R3	100%***
			C (control)	0%*
4	*Salvadorapersica*	20°C	R1, R2, R3	> 50% < 100%**
			C (control)	0%*
		30°C	R1, R2, R3	100%***
			C (control)	0%*
		40°C	R1, R2, R3	100%***
			C (control)	0%*
5	*Senna alexandrina*	20°C	R1, R2, R3	> 50% < 100%**
			C (control)	0%*
		30°C	R1, R2, R3	100%***
			C (control)	0%*
		40°C	R1, R2, R3	100%***
			C (control)	0%*

*Negative acceptability with no interest of the animals.
**Accepted acceptability which also involves partial eaten forage by elderly animals with lesser interest.
***Good acceptability which involves 100% of the eaten forage with interest.

the digested plant material of these plants may indirectly stop overgrazing, restore the flora and conserve plant diversity in the studied region of the Saudi Arabia.

It is well known fact that the anaerobic digestion is affected by many factors, including the pH, moisture content, temperature, retention time, and the carbon and nitrogen content[6-8]. The present study has considered only one parameter, temperature, during the tenure of the experiment. Therefore, there is a possibility that the acceptability of the studied digested plants can be improved further if the pH, moisture content, retention time, and the carbon and nitrogen content are also controlled at specific levels.

CONCLUSION

This study was carried out on five plants and in a small region of the Saudi Arabia. The result of three digested plants were promising. The present study has opened a door to carry out similar studies in other region of the Kingdom and at large scale and on a large number of non palatable pastoral plants. It is also believed that the acceptability of the studied digested plants can be improved further by controlling the pH, moisture content, retention time, and the carbon and nitrogen content at specific levels during the tenure of the experiment. Therefore, further studies are recommended in this direction.

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