

Research Article

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Effects of Some Additives on *In Vitro* True Digestibility of Wheat and Soybean Straw Pellets

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Abstract: This study was aimed to explore the nutrient content, relative feed values (RFV) and *in vitro* true digestibilities (IVTD) of wheat straw and soybean straw pellets produced with the addition of molasses, guar meal and sepiolite. In this experiment, 16 groups were created for 2 different straws (wheat/soybean straws), 2 different sepiolite applications (available/not available) and 4 different applications (control, guar meal, molasses, guar meal+molasses) in accordance with the 2x2x4 factorial design. A Daisy incubator was used to determine the IVTD of the feeds. According to the results, molasses and guar meal increased the RFV of soybean straws, while molasses and guar meal treatments and sepiolite did not affect the RFV of wheat straws. It was observed that sepiolite increased the RFV's of soybean straw for guar meal and guar meal+molasses. The higher IVTD's were found for guar meal (without sepiolite) treatment of soybean straw and guar meal (with sepiolite) treatment of wheat straw. Molasses and guar meal addition to wheat and soybean straws improved the crude protein contents. In conclusion, straw pelleting can be used as an alternative forage conservation method to close the gap in forage supply during the winter.

Keywords: Guar meal, *in vitro* digestibility, molasses, pellet, sepiolite, soybean straw, wheat straw

1 Introduction

Forages are feed sources with significant functions with regards to rumen physiology. Straws have an important potential for forage as they are abundant and relatively

cheap. Straws are classified as poor quality forages due to their low protein, but high fiber, content. Therefore, practices focusing on improving the nutritive value of straws are of utmost importance in closing the gap in quality forage supply [1]. Thus, economic benefits will be possible for ruminant farming using quality forages instead of expensive compact feed sources. Physical (grinding, pelleting, steam processing, etc.), chemical (urea, ammonia, etc. treatment), and biological (bacteria, fungi, enzymes etc.) methods are used to increase the nutritive value of straws. Straws are commonly subjected to practices aimed at increasing their nutritive values by the addition of urea and molasses [2, 3]. Nevertheless, it is known that some clay minerals such as sepiolite have positive impact on the digestibility of the feed [4].

The use of silage and hay is often insufficient in meeting the feed requirements of ruminants during the winter. Recently, some forages such as alfalfa have been pelleted to be used in livestock farming. It was observed that forage pelleting reduced the scattering of the feed by animals, ensures homogeneity of the forage, and increased the feed conversion rate by 4-6% [5, 6]. Moreover, pelleting is also important in closing the gap in the need for quality forage in the winter as it offers an alternative forage storage method for livestock farmers. In addition, the advantages of pelleting poor quality forages over quality forages has been reported [7].

It was reported that a 15% molasses addition to straws increased the feed consumption of cattle, live weight gain (LWG) and milk production [8], while a 9% molasses addition increased the amount of milk fat [9]. In addition to increasing the nutritive value of the forage, molasses also increased the pellet quality [10]. Containing high amounts of galactomannan gum, guar meal are rich in *lysine* and *methionine* and offer 50-55% crude protein content. In this context, guar meal is effective in increasing the protein content of straws with poor protein content. Furthermore, it also increased the pellet quality due to its pellet binding quality [11]. According to Diaz et al. [12], the most important effect of sepiolite in ruminant rations is that it provides the ammonia to the rumen medium

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necessary for microbial protein synthesis. It may also protect the animal against the accumulation of ammonia at toxic levels, with microbes having adsorbed the excess ammonia which may be produced in the rumen. With this respect, it is believed that sepiolite use is advantageous both for forage quality and animal health.

The current annual wheat production in the world adds up to 729.0 million tons while annual soybean production adds up to 307.0 million tons [13]; produced 1 to 1.5 times more than the total grain production [14], straws have a great potential for forage. This study was designed to determine if the nutritive value of wheat straw and soybean straw could be increased by applying a pelleting process and with the addition of molasses, guar meal and sepiolite. We also aimed to explore the *in vitro* true digestibility of the final products. The study was designed in line with the hypothesis that the additives explored in this study, in connection with wheat straw and soybean straw pellets, will have a positive effect on the nutritive value of forages and their digestibilities.

2 Materials and Methods

In this study, wheat straws and soybean straws used as feed material were obtained from 3 different locations. Sugarbeet-molasses (crude protein:7.5%), urea (nitrogen:46.0%), guar (*Cyamopsis tetragonoloba*) meal (crude protein:43.4%) and sepiolite were used as additives in order to increase the nutritive value of straws.

2.1 Establishment of treatment groups

Eight groups for each straw type (wheat and soybean) were created: 2 sepiolite applications (available – not available) and 4 treatments (control, guar meal, molasses and guar meal+molasses). The ratios used in this study were as follows: sepiolite 2% [15]; molasses 7% [16]; guar meal 10% [17]; guar meal + molasses 17%. Additives and straws were blended homogeneously and then each group was pelleted in 6 mm diameter pellets with 3 iterations.

2.2 Chemical analyses

The straws were milled in a hammer mill through a 1 mm sieve to determine the chemical compositions and for the *In Vitro True Digestibilities* assays. The samples were analyzed according to AOAC [18] procedure for ash, dry

matter (DM) and nitrogen (N) contents. Crude protein was calculated by multiplying N by 6.25. The acid detergent fiber (ADF), neutral detergent fiber (NDF), crude fiber (CF) and acid detergent lignin (ADL) analysis were performed according to the method of Van Soest *et al.* [19] using an Ankom^{A2000} fiber analyser. The ether extract (EE) content was determined with the Ankom^{XT15} analyzer according to AOCS [20]. The contents of nitrogen free extract were determined by calculation. All chemical analyses of straws were carried out in triplicate.

2.3 Determination of *in vitro* true digestibilities

The rumen content used for the *in vitro* study consisted of 2 handfuls rumen content collected from 3 Simmental bulls (Average 18 months of age and 450-550 kg live weight) that were slaughtered at a local slaughterhouse. The bulls were fed twice daily with a diet containing good quality grass hay and maize silage (60%) and concentrates (40%). The contents were brought to the laboratory within 15-20 minutes in thermos (39.0°C). The rumen content was then mixed, taken under CO₂ atmosphere and filtered through two layers of cheesecloth. A Daisy incubator makes the *in vitro* NDF disappearance study simple and efficient because it uses equipment designed with four rotating digestion jars and maintains constant, uniform heat and agitation within a controlled (39.0°C) chamber [19, 21]. The Daisy incubator instrument contains 4 cylinder incubators, with 1 cylinder requiring 1600 ml buffer solution and 400 ml rumen fluid as inoculums and filter bags (25 pieces). Approximately 500 mg dry weight of straws were placed into the filter bags (nitrogen free). Then, each filter bag was placed inside each of the other cylinders with solution. The cylinder was aerated for 30 seconds with CO₂ immediately before being tightly closed placed into incubator for 48h. After incubation, filter bags were cleaned with water and dried (105 °C, 3 hours). The bags were analyzed for NDF digestibility with a fibre analyzer. The *In vitro experiment* was carried out in five repetitions. *In vitro* true digestibilities of straws was estimated as follows:

$$\text{IVTD, \%} = 100 - ((W_3 - (W_1 \times C_1)) * 100) / W_2$$

where : W1: Weight of filter bag, W2: Weight of sample, W3: Final weight after NDF analysis, C1: The bag without sample was prepared also for correction.

2.4 Determination of rumen fluid pH, volatile fatty acids (VFA) and ammonia-N ($\text{NH}_3\text{-N}$) contents

The pH value of rumen fluid was determined by using Hanna 1332 digital pH meter with 3 replications. The volatile fatty acids analysis of rumen fluid was performed by using gas chromatography (Agilent Technologies 6890N GC. Cat. 11023, Maximum temperature: 260°C, Stabilwax-DA, 30 m, 0.25 mm ID, 0.25 μm df.) according to Wiedmeier et al. [22]. Rumen fluid $\text{NH}_3\text{-N}$ analysis was determined by using the Kjeldahl methods according to Blümmel et al. [23] in 3 replicates.

2.5 Determination of relative feed values

Relative feed values of straws were calculated as following [24];

$$\text{Dry matter digestibility (DMD, \%)} = 88.9 - (\text{ADF\%} \times 0.779)$$

$$\text{Dry matter intake (DMI, live weight, \%)} = 120 / (\text{NDF\%})$$

$$\text{Relative feed value (RFV, \%)} = (\text{DMD} \times \text{DMI}) / 1.29$$

According to the Quality Grading Standard assigned by The Hay Marketing Task Force of the American Forage and Grassland Council, the RFV were assessed as roughages based on prime >151, 1 (premium) 151-125, 2 (good) 124-103, 3 (fair) 102-87, 4 (poor) 86-75, 5 (reject) < 75.

2.6 Statistical Analysis

The data obtained from the experiments were analyzed using the SPSS 20.0 software package. The data regarding nutrient content, *in vitro* true digestibility were subjected to GLM procedure in accordance with the completely randomized factorial design controlling for normality and variance homogeneity.

3 Results

Nutritional contents of each treatment are shown in Table 1. Sepiolite addition increased the ash content in all groups except WC, SC and SG ($P < 0.001$). As soybean straws are legume forage, they proved to have a higher CP content ($P < 0.001$). It was found that any additive used in combination with wheat straw increased the CP

content while it was observed that the CP content was increased in SG and SGM groups ($P < 0.001$). It was found that sepiolite decreased the CP content in WM, WGM, SC and SGM groups ($P < 0.001$). Higher CF and lower NFE was found in soybean straws when compared to wheat straws ($P < 0.001$).

NDF content of straws was found to be lower in the WGM group compared to the WC group ($P < 0.001$). It was found that the NDF content was decreased in SM, SG and SGM treatments when compared to SC treatment ($P < 0.001$). Sepiolite addition decreased the NDF content in SM and SGM treatments ($P < 0.001$). Additives and sepiolite did not affect the ADF content of wheat straws ($P > 0.05$). However, sepiolite addition decreased the ADF content of the soybean straws ($P < 0.001$). ADL content of soybean straw was found to be higher than the one of wheat straw ($P < 0.001$). It was found that guar meal addition to soybean straw decreased the ADL content, while sepiolite addition decreased the ADL content only in WC and WM groups ($P < 0.001$). However, additives and sepiolite addition had no effect on the ADL content of wheat straws.

The contents of the rumen fluid were found to have a pH of 6.15 (6.08-6.51), total volatile fatty acid=TVFA: 92.82 ± 0.67 mmol/L, acetic acid: 49.81 ± 0.12 mmol/L, propionic acid: 23.37 ± 0.44 mmol/L, butyric acid: 15.83 ± 0.72 mmol/L, isobutyric acid: 1.89 ± 0.32 mmol/L, isovaleric acid: 0.98 ± 0.05 mmol/L and valeric acid: 0.94 ± 0.08 mmol/L and $\text{NH}_3\text{-N}$ contents: 29.65 ± 2.04 mg/100 ml (296,5 mg/L).

Table 2 shows the effects of additive supplementation to wheat and soybean straws on forage quality and *IVTD*. Additives had no effect on wheat straw with respect to dry matter digestibility (DMD) ($P > 0.05$), while wheat straws showed digestibility results similar to those of soybean straws with guar meal addition. Nevertheless, sepiolite addition increased the DMD in SGM group ($P < 0.001$).

The WC+S group showed the lowest value among other wheat straws with respect to dry matter intake (DMI), while DMI showed an increasing trend in groups with guar meal addition. In soybean straws, the highest value was obtained from SG groups ($P < 0.001$). Soybean straws gave higher DMI values when compared to wheat straws. Sepiolite addition to the SG group of soybean straws decreased the DMI while increasing the DMI in SM and SGM groups ($P < 0.001$). In control groups, however, the sepiolite effect on DMI was negligible.

Additives and sepiolite addition had no effect on the relative feed value (RFV) of wheat straws ($P > 0.05$). In soybean straws, SG group proved to have the highest RFV value. Nevertheless, sepiolite addition to SG treatment

Table 1. Chemical composition of straw treatments, % DM

Treatments*	DM*	Ash	CP	EE	CF	NFE	NDF	ADF	ADL
WC	90.46±0.06 ^e	8.37±0.31 ^{e/g}	4.63±0.00 ^e	0.62±0.10	42.58±0.76 ^e	43.81±0.93 ^a	76.68±0.43 ^b	46.89±0.42 ^d	5.27±0.20 ^e
WC+S	91.44±0.01 ^c	8.17±0.34 ^g	3.87±0.07 ^e	0.73±0.38	42.55±1.01 ^e	44.67±1.49 ^a	79.27±0.80 ^a	47.55±0.51 ^d	5.99±0.66 ^e
WM	88.90±0.05 ^s	9.21±0.25 ^{def}	6.93±0.05 ^d	1.40±0.35	45.51±1.01 ^{bode}	36.94±1.18 ^{bcd}	76.55±0.53 ^b	47.42±0.27 ^d	6.98±0.31 ^e
WM+S	87.84±0.07 ⁱ	10.89±0.32 ^c	5.08±1.84 ^e	1.01±0.37	43.47±3.26 ^{de}	39.56±1.28 ^{abc}	75.29±0.66 ^{bc}	46.06±0.45 ^d	6.23±0.61 ^e
WG	91.84±0.03 ^b	7.54±0.16 ^g	6.82±0.12 ^d	0.86±0.24	42.82±1.86 ^e	41.97±1.88 ^{ab}	75.66±0.49 ^{bc}	45.75±0.75 ^d	5.34±0.44 ^e
WG+S	92.35±0.01 ^a	9.37±0.30 ^{de}	7.17±0.10 ^d	0.35±0.15	41.21±2.23 ^e	41.88±1.90 ^{ab}	74.89±0.45 ^{bc}	45.51±0.15 ^d	5.37±0.45 ^e
WGM	88.50±0.10 ^h	8.53±0.31 ^{e/g}	11.8±0.22 ^{ab}	0.88±0.29	41.02±1.91 ^e	37.77±2.06 ^{bcd}	73.94±0.28 ^{cd}	45.69±0.22 ^d	5.83±0.07 ^e
WGM+S	87.65±0.19 ^j	9.81±0.49 ^d	9.96±0.15 ^c	0.70±0.13	43.41±2.83 ^{de}	36.12±2.93 ^{cdef}	73.89±0.71 ^{cd}	45.36±0.32 ^d	5.49±0.37 ^e
SC	88.76±0.12 ^s	8.53±0.33 ^{e/g}	8.41±0.18 ^d	0.65±0.06	49.47±1.57 ^{abc}	32.95±1.64 ^{defg}	75.02±0.53 ^{bc}	58.84±0.97 ^a	16.08±0.53 ^a
SC+S	90.91±0.05 ^d	8.37±0.50 ^{e/g}	4.59±0.02 ^e	0.85±0.16	52.22±1.36 ^a	33.97±0.80 ^{defg}	72.50±0.04 ^d	57.37±0.47 ^a	12.71±0.19 ^d
SM	84.68±0.12 ^l	11.86±0.25 ^b	8.20±0.04 ^d	0.60±0.51	50.41±1.44 ^{ab}	28.93±0.68 ^{ghi}	70.14±1.12 ^{ef}	53.91±1.38 ^{bc}	15.87±0.12 ^a
SM+S	85.84±0.09 ^k	14.74±0.32 ^a	8.04±0.23 ^d	0.54±0.12	45.07±1.55 ^{bode}	31.60±1.48 ^{efg}	66.25±0.38 ^g	53.55±2.34 ^{bc}	13.90±1.34 ^{bc}
SG	90.20±0.12 ^f	14.79±0.20 ^a	11.18±0.49 ^{abc}	0.78±0.35	39.42±0.86 ^e	33.83±1.16 ^{defg}	58.54±0.66 ⁱ	45.30±1.01 ^d	12.12±0.37 ^d
SG+S	90.13±0.03 ^f	14.36±0.25 ^a	10.51±0.09 ^{bc}	0.27±0.04	43.96±1.71 ^{cde}	30.90±1.91 ^{fgh}	62.52±1.54 ^h	46.93±0.96 ^d	11.40±0.16 ^d
SGM	84.01±0.09 ^m	7.59±0.45 ^g	12.72±0.76 ^a	0.82±0.44	52.68±1.33 ^a	26.18±1.94 ^{hi}	71.86±0.96 ^{de}	56.27±0.55 ^{ab}	14.69±0.54 ^{ab}
SGM+S	86.87±0.06 ^l	14.59±0.20 ^a	10.84±0.04 ^{bc}	0.71±0.32	49.11±2.33 ^{abcd}	24.76±2.45 ⁱ	68.06±0.83 ^{fg}	51.53±1.25 ^c	13.93±0.88 ^{bc}
Significance	<0.001	<0.001	<0.001	0.650	<0.001	<0.001	<0.001	<0.001	<0.001
Effects	DM*	Ash	CP	EE	CF	NFE	NDF	ADF	ADL
Straw	0.000	0.000	0.000	0.257	0.000	0.000	0.000	0.000	0.000
Sepiolite	0.000	0.000	0.000	0.217	0.692	0.873	0.061	0.105	0.003
Additive	0.000	0.000	0.000	0.463	0.001	0.000	0.000	0.000	0.000
Straw*Sepiolite	0.000	0.001	0.259	0.686	0.965	0.728	0.029	0.332	0.006
Straw*Additive	0.000	0.000	0.004	0.321	0.003	0.501	0.000	0.000	0.016
Sepiolite*Additive	0.000	0.000	0.035	0.447	0.176	0.257	0.001	0.123	0.450
Straw*Sepiolite*Additive	0.000	0.000	0.025	0.976	0.094	0.901	0.001	0.085	0.093

DM: Dry matter, CP: Crude protein, EE: Ether extract, CF: Crude fibre, NFE: Nitrogen free extracts, NDF: Neutral detergent fibre, ADF: Acid detergent fibre, ADL: Acid detergent lignin. a,b,c,....: Means with different superscripts in the same column are significantly different. WC: Wheat control, WM: Wheat molasses, WG: Wheat guar meal, WGM: Wheat guar meal+molasses, SC: Soybean control, SM: Soybean molasses, SG: Soybean guar meal, SGM: Soybean guar meal+molasses, +S: with sepiolite

Table 2. Forage qualities and IVTD values for straw treatments and interactions

Treatments	DMD, %	DMI, % LW	RFV	Quality Class	IVTD, %
WC	52.37±0.33 ^a	1.56±0.01 ^{hi}	63.54±0.49 ^{cd}	5-Reject	54.50 ± 1.71 ^{bcdef}
WC+S	51.86±0.40 ^a	1.51±0.01 ⁱ	60.88±1.07 ^{def}	5-Reject	51.84 ± 1.51 ^{efgh}
WM	51.96±0.21 ^a	1.57±0.01 ^{hi}	63.15±0.24 ^{cde}	5-Reject	53.93 ± 1.17 ^{cdefg}
WM+S	53.02±0.35 ^a	1.59±0.01 ^h	65.52±0.38 ^{cd}	5-Reject	52.30 ± 0.59 ^{defgh}
WG	53.26±0.58 ^a	1.59±0.01 ^h	65.50±1.13 ^{cd}	5-Reject	53.90 ± 0.48 ^{cdefg}
WG+S	53.45±0.12 ^a	1.60±0.01 ^{gh}	66.39±0.26 ^c	5-Reject	58.64 ± 0.86 ^b
WGM	53.30±0.17 ^a	1.62±0.01 ^{fgh}	67.06±0.20 ^c	5-Reject	56.76 ± 2.54 ^{bcd}
WGM+S	53.56±0.25 ^a	1.62±0.02 ^{fgh}	67.45±0.95 ^c	5-Reject	54.19 ± 1.47 ^{bcdef}
SC	43.06±0.76 ^d	1.60±0.01 ^{gh}	53.41±1.19 ^g	5-Reject	50.51 ± 0.94 ^{fgh}
SC+S	44.21±0.37 ^d	1.66±0.00 ^{efg}	56.73±0.49 ^{fg}	5-Reject	49.44 ± 1.36 ^{gh}
SM	46.91±1.08 ^{bc}	1.71±0.03 ^{de}	62.28±2.39 ^{cde}	5-Reject	51.71 ± 0.64 ^{efgh}
SM+S	47.18±1.82 ^{bc}	1.81±0.01 ^c	66.28±2.83 ^c	5-Reject	56.24 ± 1.84 ^{bcde}
SG	53.61±0.79 ^a	2.05±0.02 ^a	85.23±2.15 ^a	4-Poor	64.50 ± 1.11 ^a
SG+S	52.34±0.75 ^a	1.92±0.05 ^b	78.03±3.01 ^b	4-Poor	58.11 ± 1.66 ^{bc}
SGM	45.06±0.43 ^{cd}	1.67±0.02 ^{ef}	58.38±1.35 ^{ef}	5-Reject	48.32 ± 0.79 ^h
SGM+S	48.76±0.97 ^b	1.76±0.02 ^{cd}	66.69±2.08 ^c	5-Reject	57.84 ± 1.70 ^{bc}
Significance	<0.001	<0.001	<0.001		<0.001
Effects	DMD, %	DMI, % LW	RFV		IVTD, %
Straw	0.000	0.000	0.236		0.912
Sepiolite	0.103	0.145	0.142		0.423
Additive	0.000	0.000	0.000		0.000
Straw*Sepiolite	0.331	0.104	0.243		0.121
Straw*Additive	0.000	0.000	0.000		0.000
Sepiolite*Additive	0.122	0.000	0.009		0.040
Straw*Sepiolite*Additive	0.084	0.000	0.005		0.000

DMD: Dry matter digestibility, DMI: Dry matter intake, RFV: Relative feed value, IVTD: In Vitro True digestibility, WC: Wheat control, WM: Wheat molasses, WG:Wheat guar meal, WGM: Wheat guar meal+molasses, SC: Soybean control, SM: Soybean molasses, SG: Soybean guar meal, SGM: Soybean guar meal+molasses, +S: with sepiolite. a,b,c,... Means with different superscripts in the same column are significantly different.

decreased the RFV while increasing the RFV in the SGM group ($P<0.001$). According to the quality classification performed with respect to the RFV index, it was found that guar meal addition to soybean straw improved the forage quality from “5-Reject” to “4- Poor”.

Digestibility of the forages is of utmost importance when identifying their feed values. There was no effect of the treatments on IVTD in wheat straw, and the lowest IVTD value was obtained from the sepiolite addition to the WC group. The highest IVTD value was obtained in the WG groups; and sepiolite addition (WG+S) increased the IVTD ($P<0.001$). Similarly, highest IVTD value was obtained from the SG groups while it was found that IVTD was decreased with the sepiolite addition (SG+S) ($P<0.001$). In the SGM+S groups, on the other hand, sepiolite addition increased the IVTD value ($P<0.001$).

4 Discussion

Increased ash content of the feed decreases the nutritive values of the feedstuffs. High ash content is an indicator of the availability of contaminants such as soil, sand, clay, etc. in the feed and mineral content of the feed. The ash content (8.53%) found in this study for soybean straw (SC) was in agreement with the results of other studies (range of 7.2-13.7%) [3, 25, 26]. The ash content (8.37%) observed in this study for wheat straw (WC) was also in agreement with the results of other studies (range 5.2-10.1%) [3, 27, 28].

It is known that guar meal offered high amounts of CP (43.4%) which in return increased the CP content of straws. Sepiolite treatments caused a decrease in the CP content of the straws. Thus, CP content decreased in ratio. Various studies have reported typical CP contents for

soybean straw in the range of 3.64% -9.2%. [3, 25, 29, 30], while the CP content of wheat straws has had a reported range of 2.9-4.8% [28- 33]. The CP contents observed in this study were consistent with the ranges reported in the literature [3, 28-31]. Factors such as plant variety, soil structure, fertilization, harvest time, stalk and weed seed ratios of the straws, etc., have all been noted as possible variables that affect these values [34].

The crude fibre content of soybean straw has been previously reported between 38.1% - 53.1% [3, 25, 35]. The CF content of wheat straw was found to be 42.58% in this study, at the upper end for previously reported values (38.1- 42.5%) [3, 33; 35, 36].

As feed, higher NDF contents will be consumed in lower amounts by ruminants [37], and the consumption of wheat straw will be lower than the consumption of soybean straws. The NDF content of soybean straw was reported by Mohamoud Abdi [3], Maheri-Sis et al. [26] and Mule et al. [25] as 71.46%, 80.8% and 52.0%, respectively. The value (75.0%) obtained in this study for soybean straw (SC) was similar to these reports. The NDF content (76.68%) of wheat straws reported in this study was in the range (54.4% - 85.1%) reported by a number of authors [3, 27, 28, 31, 37]. However, molasses addition to WS was expected to increase the feed consumption as it decreased the NDF content.

A low ADF content is an indicator of digestibility in feed; wheat straws were found to have a higher digestibility when compared to soybean straws. On the other hand, an increase in the digestibility was observed in the SM and SG groups of soybean straw when compared to the SC treatment. Therefore, molasses and guar meal addition is recommended for soybean straws. An ADF content range of 53.4% - 63.2% for soybean straw (SC) [3, 26, 29] has been reported, in agreement with the amount (58.84%) found in this study. The ADF value reported by some researchers [3, 27, 37] for wheat straw range from 47.5% -57.1%. The ADF content (46.89%) reported in this study for wheat straw was in agreement with the lower limit of these published accounts. We found that molasses and guar meal addition are recommendable for soybean straw as they decreased the ADF content, increasing its digestibility.

In terms of the relative feed value, physical and chemical processes performed on feed (additives, etc.) have an impact on their biological values [37]. The lower the NDF and ADF contents of the feed, the higher the RFV index of the forage. In other words, lower NDF and ADF contents indicate that the feed is classified under a quality forage class. Considering that the feed with high dry matter intake is consumed more by animals, it can be said that molasses addition or guar meal and molasses addition to soybean straws will have an appetizing effect.

Guar meal addition to soybean straws increased the RFV, yet, the same effect was not the case for wheat straws. Similarly, *In vitro* true digestibility was increased in soybean straws, while IVTD was decreased with sepiolite addition with wheat straw. This result may be due to the different lignocellulosic structures wheat and soybean straws have [3].

The relative feed value calculated using the ADF and NDF data previously reported for wheat was 53.15 - 75.38 and, for soybean straws, was (45.67 - 84.62) [3, 25; 26; 27, 29, 31] The RFV value for this study was 63.54 for the WC treatment, and in the range of 60.88- 67.45 for all wheat straw treatments. The RFV value was in the range of 53.41- 85.23 for soybean straw in this study, again in agreement with the literature reports. In the light of these results, it can be said that additives used in this study had a positive effect on RFV and increased the forage quality. RFV was higher in soybean straws in groups with guar meal addition, as the NDF content of guar meal was lower than soybean straw.

Sahan [33], Yilmaz [38], and Bozkurt et al [39] reported *In vitro* true digestibility values of 24.79%, 43.53%, 46.8%, respectively, for WS. The values observed in this study were higher than those literature reports. Such a difference may be caused by feed variety used in the experiments, fertilization practices, harvest time, feed processing (pelleting, grinding) and the differences in the application of the *in vitro* digestibility method [34]. Mohamoud Abdi [3] reported that the addition of molasses to WS and urea+molasses treatments increase IVTD. In this study, it was found that IVTD of WGM treatment was higher than the control group, however, molasses addition by itself did not offer any significant change in IVTD.

IVTD of soybean straw was reported as 40.11% by Mohamoud Abdi [3], and it was found that molasses and urea+molasses addition increased IVTD value. Wan et al. [40] reported that hot water and NaOH treatment increased the cellulose digestibility of soybean straw. In this study, IVTD of SC was found to be 50.51%. Although, molasses addition and urea+molasses treatments did not affect the IVTD of soybean straws, the IVTD was increased significantly by sepiolite addition. This finding shows that sepiolite plays a more effective role on IVTD in groups with molasses addition, as molasses is rich in water soluble carbohydrates. As soybean straw has a higher lignin content compared to wheat straw, soybean straw offered a lower digestibility value in control groups. This may be due to varying harvest times and different lignocellulosic structures of the straws. Nevertheless, it is clear that additives generally improved the digestibility of soybean straw.

5 Conclusions

It was found that additives can be used to improve the feed values of wheat and soybean straws. In this study, sepiolite addition to wheat straw had no effect on RFV, while RFV was higher in the SG and SGM treatments when compared to other groups. It was found that guar meal addition to soybean straw partially improved the forage quality. Moreover, the highest IVTD was obtained when guar meal was added to straws and it was found that sepiolite addition gave higher IVTD results in groups with guar meal addition. IVTD improved in all treatments with molasses and sepiolite addition. In conclusion, when pelleted with additives, soybean and wheat straws can be used in animal feed. The most important advantage of pelleting is the homogeneity of straw and additives. Thus, it is possible to mix sepiolite and guar meal additives in granular form with straw in a homogeneous manner and to then preserve such homogeneity.

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Abbreviation List

DM: Dry matter
 CP: Crude protein
 EE: Ether extract
 CF: Crude fibre
 NFE: Nitrogen free extracts
 NDF: Neutral detergent fibre
 ADF: Acid detergent fibre
 ADL: Acid detergent lignin.
 WC: Wheat control,
 WM: Wheat molasses,
 WG:Wheat guar meal,
 WGM: Wheat guar meal+molasses,
 SC: Soybean control,
 SM: Soybean molasses,
 SG: Soybean guar meal,
 SGM: Soybean guar meal+molasses,
 +S: with sepiolite

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