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Evaluating the Effect of Adding Natural Plant Sources of Unsaturated Fatty Acids without or with Seaweed on the Digestion of Sheep

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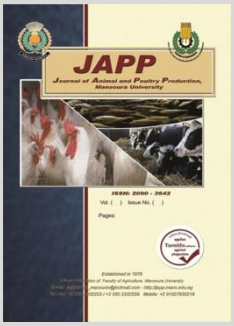

ABSTRACT

This experiment was carried out on the animal production department of the faculty of agriculture at Al-Azhar university, Nasr City, Cairo, Egypt, and Noubaria experimental station, by-Products utilization department, animal production research institute, agricultural research center, Ministry of Agriculture, Egypt. An experiment to estimate the effect of adding plant sources of unsaturated fatty acids on the performance of sheep16 formulations were made to contain sunflower oil (SUN), linseed oil (LIN), and marine algae. The disappearance of dry and organic matter, protein, and the efficiency of degradation in the rumen were estimated. Algae (8%) without additives or algae (2%) mixed with SUN (2%) recorded the highest rate of disappearance of dry and organic matter, although they were less efficient in protein disappearance, Based on these results, the four best formulations were chosen to form TMR diets with the control to estimate digestibility parameters and nutritional values when fed to sheep as follows: 1. control diet (60% concentrated feed mixture and 40%berseem and rice straw), 2. control + 2% sunflower oil + 2% algae, 3. control + 1%SUN + 1% LIN oil + 4% algae, 4. control + 2% LIN oil + 2% algae, and 5. control + 8% algae. The results showed that the second followed by the fifth diets recorded the highest efficiency in dry and organic matter degradation in the rumen, the highest digestion coefficients and nutritional value (TDN), and the highest nitrogen utilization of diet, Therefore, it can be concluded that adding sunflower oil with algae has a great benefit on digestion in sheep, followed by LNS oil as alternative if SUN is not available.

Keywords: sunflower oil, linseed oil, green algae, disappearances, digestibility

INTRODUCTION

The metabolism and digestion of fat and fatty acids in ruminants are currently of great interest to scientists and the agricultural sector. Rekindled interest in the topic stems from two factors: first, dietary fat supplements are becoming more popular and will stay so as nutritionists work to make diets more energy dense in order to meet the needs of high-producing dairy cows; and second, we now know that fatty acids, both dietary and rumen-derived, can have powerful effects on human health and ruminant metabolism (de Souza, J. and A. L. Lock, 2018).They form part of the membrane in this way and are precursors to other unsaturated fatty acids that are essential for controlling metabolism and are essential to life for all mammals (Mavangira, V. and L. M. Sordillo, 2018).

Nonetheless, because of their beneficial effects on general health, unsaturated fats are referred to as good or healthy fats. They are vital nutrients that help the body perform many different tasks. The majority of unsaturated fats come from oils that are extracted from fish, plants, and marine algae. These fats can be classified as polyunsaturated (flax oil, sunflower oil) or monounsaturated (olive oil). Apart from fish oil, the most significant plant sources of these fats are seeds and vegetable oils, such as linseed, sunflower, canola, and olive oils. In addition to being high in calories, consuming unsaturated fats has been associated with several health advantages, including heart health support, inflammation reduction, and improved vitamin absorption. Additionally, it is essential for raising the milk fat of goats, ewes, or dairy cows (Rabiee *et al.* 2012).

Therefore, the purpose of this study was to examine how adding some natural sources of unsaturated fatty acids affected the ruminant's ability to digest.

MATERIALS AND METHODS

With the assistance of the Animal Production Department of the Faculty of Agriculture at Al-Azhar University, Nasr City, Cairo, Egypt, and Noubaria Experimental Station, By-Products Utilization Department, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt, this study was conducted from January 2019 to June 2020. This study sought to ascertain the impact of utilizing various unsaturated fatty acid sources (sunflower or linseed oil) with or without seaweed (algae) on ruminant digestion.

Seaweed (Algae) preparation and formulation of experimental rations:

Seaweed was hand-selected and gathered from Alexandria, Egypt's Mediterranean Sea shore, using a scalpel. The green alga, or U. lactuca, was the species of seaweed that was collected. After thoroughly washing the seaweed three times with fresh water to get rid of the salt, it was sun-dried for three days and then oven-dried for 72 hours at 60°C. It was ground using a Wiley mill grinder until it passed a 1.0 mm screen. Algal sample composition was examined using AOAC (1995) guidelines. Inductively coupled plasma emission spectrometry (ICP) was used to measure the content of minerals (AOAC, 1998).

The following combinations of the tested oils (sunflower oil or linseed) were used in a number of on-site

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experiments (16) with or without varying percentages of seaweed (algae) (2, 4 or 8% of DM intake) :- 1) Concentrated feed mixture (CFM) without any additional ingredients. 2) Same in 1 with sunflower oil (1+ 2%sunflower oil). 3) same in 1+ 2% algae + 2% sunflower oil (low). 4) Same in 1 plus 2% sunflower oil plus 4% algae. (medium). 5) The same in 1 plus 2% sunflower oil plus 8% algae (strong). 6) the same in 1 + 1% linseed oil + 1% sunflower oil.7) same in 1+1% linseed oil + 1% sunflower oil + 2% algae. 8) Same in 1 + 1% linseed oil + 1% sunflower oil + 4% algae. 9) Same in 1+1% linseed oil +1% sunflower oil +8% algae. 10) Same in1 + linseed oil (1+ 2%linseed oil). 11) Same in 1 + 2% algae + linseed oil (2%). 12) same in 1 plus 2% linseed oil plus 4% algae. 13) The same in 1 plus 2% linseed oil plus 8% algae. 14) same in 1 + 2% of algae, 15) same in 1 + 4% of algae. 16) Same in 1 + 8% algae.

In - Situ ruminal degradability of tested combination:

According to Mathers, and Miller (1981), three fistulated ewes were utilized to measure the rate of DM, OM, and N loss using nylon bags for each combination. Each bag (6 cm × 12 cm and 53 μm pore size) held 5 grams of ground samples (as-fed basis) and was incubated in the ventral part of the rumen. After 0, 2, 4, 6, 12, 24, 48, and 72 hours, the bags were removed. The bags marked with a zero hour were not incubated; instead, they were removed from the rumen and treated in the same way as other bags, which included a 25-minute rinse with tap water. Based on the incubation residues, it was possible to determine when DM and OM vanished from the bags. The percentage of in-situ DM and OM disappearance was calculated using the following equations: DM % disappearance = {(weight of sample dry x DM%) — (weight of remaining sample after incubation and drying)} / weight of sample dry x DM%) x 100 and In-situ OM% disappearance = {(weight of sample dry x OM%) — (weight of remaining sample after incubation and burning)} / (weight of sample dry x OM %) x 100.

The top five combinations were chosen to carry out an experiment on digestion and to estimate feeding values. These were the experimental rations :

1) T1 = Concentrated feed mixture CFM (60%) + (berseem+ rice straw) (40%) (Control).
2) T2 = control + 2% sunflower oil + 2% algae.
3) T3 = control + 1% sunflower oil+ 1% linseed oil +4% algae.
4) T4 = control + 2% linseeds oil+ 2% algae
5) T5 = control + 8% algae.

* Composition of CFM is presented in Table (1) and chemical analysis of the feed components is shown in Table (2). Chemical composition and fiber fractions of five experimental rations is show in table (3).

Table 1. Composition of the experimental concentrate feed mixtures (CFM) (On DM basis).

Ingredients	%
Yellow corn	37.90
Sugar beet pulp (SBP)	14.10
Wheat bran	17.50
Soybean meal	17.00
Linseed meal	5.00
Molasses	5.00
Lime stone	2.00
Salt	1.00
Minerals premix	0.50
Total	100

Minerals premix contained: Common salt (44.156 %), bone meal (25 %), calcium carbonate (10 %), potassium chloride (15 %), potassium sulphite (15 %), magnesium sulphate (0.390 %), ferrous sulphate (0.330 %), manganese (0.061 %), potassium iodide (0.010 %), zinc oxide (0.044 %) and cobalt chloride (0.009 %).

Table 2. Chemical analysis of CFM, rice straw, green berseemandgreen algae (On DM basis).

Chemical composition	CFM	Rice Straw	Green Berseem	Green Algae
DM	89.71	90.50	19.93	91.25
OM	92.57	83.86	85.42	75.65
CP	15.67	4.13	13.83	22.86
CF	6.74	35.73	25.87	1.39
EE	2.88	1.43	1.73	0.56
NFE	67.28	42.57	43.99	50.84
Ash	7.43	16.14	14.58	24.35
NDF	31.54	63.50	38.90	44.65
ADF	21.93	36.40	25.86	28.87
ADL	4.43	10.30	5.19	11.05
Hemicellulose	9.61	27.20	13.04	15.78
Cellulose	17.50	26.84	20.67	17.82

OM, organic matter; CP, crude protein; CF, crude fiber; EE, ether extract; NFE, nitrogen free extract;
NDF, neutral detergent fiber; ADF, acid detergent fiber; ADL, acid detergent lignin;

Table 3. Chemical composition of the five experimental rations fed to sheep (On DM basis).

Chemical composition	T1	T2	T3	T4	T5
DM	75.90	77.72	78.67	77.72	83.20
OM	89.89	89.41	88.92	89.41	87.95
CP	12.98	13.43	13.89	13.43	14.80
CF	17.31	17.33	17.36	17.33	17.42
EE	2.26	2.47	2.30	2.47	2.30
NFE	57.34	56.18	55.37	56.18	53.43
Ash	10.11	10.59	11.08	10.59	12.05
NDF	41.16	42.05	42.94	42.05	44.73
ADF	27.60	28.17	28.75	28.17	29.90
ADL	7.29	7.51	7.73	7.51	8.17
Hemicellulose	16.33	16.64	16.96	16.64	17.59
Cellulose	21.85	22.20	22.56	22.20	23.27

OM, organic matter; CP, crude protein; CF, crude fiber; EE, ether extract; NFE, nitrogen free extract;
NDF, neutral detergent fiber; ADF, acid detergent fiber; ADL, acid detergent lignin;

Digestibility trials

For each diet, three Barki sheep were used in the trials. Every trial had four-week duration: three weeks for preparatory work, and one week for collecting urine and feces.

According to NRC (2001), rations were given to animals twice a day at 8.0 and 16.0 to meet their maintenance needs. In accordance with A.O.A.C. (1995), the chemical composition of feeds, feces, and urine was determined. The experiment on digestion involved the calculation of feed intake. Samples of feces were dried for 72 hours at 60°C. On a Wiley mill grinder, feed and fecal samples were ground through a 1 mm screen, and the samples (50 gm/sample/treatment/sheep) were combined for further analysis. The crude protein (CP), crude fiber (CF), ether extract (EE), and ash were measured in the feed and feces samples, and nitrogen (N) was measured in the urine sample in accordance with A.0.A.C (1995).Total digestible nutrients (TDN) values were computed using the Maynard *et al.* (1978) formula.

Statistical Analysis:

Using SAS (1999) and the model:

$$Yij=\mu+Pi+eij,$$

Data were gathered to determine nutrients digestibility and dietary-N utilization. One-way analysis of variance was then applied to examine the effects of treatments.

Where: **ei = random error; Pi = experimental diet; μ = overall mean; Yij = observation trait;**

The means of the dietary treatment effect were separated using Duncan's multiple range test (Duncan, 1955), with a 5% significance level.

RESULTS AND DISCUSSION

Table (4) presented the degradation of DM, OM and CP at 72 hrs in cubation time for the sixteen formulas and its effective degradability (ED) as well. It was clear that rations 3, 8, 11 and 16 which contained (control + 2% sunflower oil + 2% algae), (control + 1% sunflower oil+ 1% linseed oil +4% algae), (control + 2% linseeds oil+ 2% algae) and (control + 8% algae)respectively, were recorded the higher values of DM and OM degradation. They were somehow close to the control for CP degradation.

According to the above results they were chosen with the control to conduct the digestibility trials.

The effective degradability (ED) in the rumen was calculated from the equation of Denham et al. (1989):

$$ED = a + [b \times c / (c + k)] \times e^{-k \times t}$$

Whereas: **is the water-soluble and rapidly degradable fraction; b is the insoluble but degradable fraction; c is the degradation rate of fraction b; and k the rumen passage rate. Passage rate was calculated at 0.074 h^{-1} from the equation developed by NRC (2001) for concentrates**

EDCP:

Effective degradability of crude protein;

RUP = 100 - ED (Orskov and McDonald, 1979).

For each of the five experimental diets fed to sheep, the kinetics of dry matter, organic matter, and crude protein degradation are shown in (Table5). In comparison to the control, there was a significant linear ($P < 0.05$) increase in the effective degradability "ED" of DM and OM when sunflower oil plus algae or algae alone supplemented. Their higher nutrient digestibility in the rumen may be the cause of this. In contrast the control ration was recorded higher($P < 0.05$) effective degradability (ED). Of CP in rations supplemented with sunflower oil plus algae or algae alone than in the control ration. The values of other rations were nearly in the middle. In-situ ruminal fermentation characteristics were more significantly impacted by the addition of sunflower oil and algae, regardless of the substrate that was incubated and represented in DM, OM, and CP for effective degradability these were sure to should reflection on the TDN value of fed the experimental rations (Table 8) conversely rumen un-degradable protein (RUP) was higher ($P < 0.05$) for rations contained sunflower oil plus algae or algae alone than that of control ration. According to in situ measurements, there was a numerical increase in ruminal DM, OM, and CP degradation in relation to the sunflower oil and algae diet (Table 5).In line with previous findings in cattle or sheep fed diets containing moderate amounts of plant oils or fish oil (FO), the current data generally imply that the addition of sunflower oil and algae to the diet has a detrimental effect on rumen function (Kucuk*et al.* 2004; Sinclair *et al.* 2005; Shingfield *et al.* 2010).

Table 4. Degradation kinetics of DM, OM and CP of the sixteen formulas at 72 hrs of incubation time (mean±SE).

G	DM		OM		CP	
	72 hrs	ED	72 hrs	ED	72 hrs	ED
1 Control	68.10±0.51^{b}	69.86±0.95^{c}	72.12±0.47^{c}	70.84±0.56^{c}	48.72±0.31^{b}	57.39±0.23^{b}
2	56.51±0.51^{cd}	61.01±1.33^{e}	58.28±0.58^{d}	60.53±2.56^{f}	51.65±0.59^{a}	61.46±1.75^{a}
3	70.82±1.66^{a}	77.61±1.48^{a}	76.91±0.62^{a}	81.15±0.77^{a}	44.43±0.11^{d}	54.47±0.44^{d}
4	61.34±0.74^{c}	65.65±1.54^{d}	58.63±0.86^{d}	65.44±1.33^{e}	51.45±0.61^{a}	60.47±0.61^{a}
5	53.36±1.36^{d}	64.67±1.73^{de}	58.30±0.78^{d}	64.82±1.56^{e}	51.77±0.55^{a}	61.47±1.35^{a}
6	52.74±0.89^{d}	62.06±0.54^{bc}	58.92±1.10^{d}	64.12±1.78^{e}	51.60±0.71^{a}	60.96±0.54^{a}
7	61.34±0.44^{c}	66.16±0.88^{d}	58.87±0.88^{d}	69.39±0.46^{d}	51.48±0.85^{a}	60.90±0.43^{a}
8	71.68±1.33^{a}	73.36±0.84^{b}	74.88±0.67^{b}	71.44±0.86^{b}	46.11±0.81^{c}	55.55±0.15^{c}
9	54.57±1.88^{d}	56.82±2.68^{f}	59.26±1.22^{d}	66.07±1.36^{e}	51.93±0.55^{a}	60.62±0.65^{a}
10	58.70±3.51^{c}	63.65±1.87^{de}	58.48±0.96^{d}	62.53±1.76^{f}	51.37±0.40^{a}	61.52±0.77^{a}
11	70.65±1.88^{a}	73.16±0.77^{b}	74.21±0.58^{b}	71.34±0.77^{b}	46.95±0.88^{c}	55.50±0.09^{c}
12	52.59±0.78^{d}	62.07±0.74^{e}	59.57±1.10^{d}	62.98±1.85^{f}	51.83±0.79^{a}	60.71±0.85^{a}
13	55.35±2.59^{cd}	67.56±1.77^{d}	58.41±0.59^{d}	61.23±2.33^{f}	51.54±0.47^{a}	60.94±0.73^{a}
14	53.35±1.08^{d}	48.94±0.66^{g}	58.27±0.68^{d}	66.83±1.16^{e}	51.87±0.68^{a}	61.23±1.85^{a}
15	52.45±1.21^{d}	54.75±3.54^{f}	58.24±0.77^{d}	65.40±1.45^{e}	50.98±1.01^{a}	60.64±0.49^{a}
16	72.20±2.43^{a}	76.10±1.33^{a}	76.54±0.46^{a}	80.86±0.86^{a}	44.50±0.21^{d}	54.04±0.36^{d}

ED = effective degradability.

Table 5. Degradation kinetics of DM, OM and CP of the five experimental rations at 72 hrs of incubation time (mean±SE).

Item	T1	T2	T3	T4	T5
			DM		
EDDM, 3 %	69.86±0.95^{c}	77.61±1.48^{a}	73.36±0.84^{b}	73.16±0.77^{b}	76.10±1.33^{a}
			OM		
EDOM, 3 %	70.84±0.56^{c}	81.15±0.77^{a}	71.44±0.86^{b}	71.34±0.77^{b}	80.86±0.86^{a}
			CP		
EDCP, 3 %	57.39±0.23^{a}	54.47±0.44^{c}	55.55±0.15^{b}	55.50±0.09^{b}	54.04±0.36^{c}
RUP	42.61±0.10^{c}	45.53±0.15^{a}	44.45±0.19^{b}	44.50±0.21^{b}	45.96±0.54^{a}

$^{a,b\ and\ c}$ Means within column with different superscripts are significantly different (P<0.05).

ED = effective degradability. RUP = rumen un-degradable protein.

In situ digestibility can be used to determine if the degradation characteristics of a plant species can be used to predict its nutritional value (Shem *et al.* 1995). Disappearance of dry matter at 72 hrs obtained in this work varied from 76% to 77% with increasing algae concentration. These values are near to the range of reported byRamírez *et al.* (2000) for

various who, shrubs with a mean of (0.68), and is closer to those obtained from sorghum contain which had (0.68)) reported by Martínez *et al.* (1995)

When goat diets included the algae Macrocystispyrifera, Mora *et al.* (2009) observed a similar behavior in the dry matter disappearance, which increased from 0.73 to 0.80 as the concentration of the algae were increased from 10% to 30%. These findings are thought to be caused by Macrocystis having a lower NDF content and a higher concentration of soluble carbohydrates, which are broken down more quickly in the rumen (Rodríguez-Montesinos and Hernández-Carmona 1991) In an experiment involving bovines, Gojón *et al.* (1998) reported a 54.8% disappearance of Sargassum (algae spp.) dry matter. The fact that they only assessed the algae could be the cause of this discrepancy. Analyzing the digestion's kinetics is crucial because it shows how much of the dry matter's nutrients the animal can absorb and assimilate (Mertens 1993).In comparison to the control diet; the soluble fraction (a) was higher in all diets that contained algae. This has to do with the algae's high soluble ash content. The minerals of Sargassum (spp.) vanished from the nylon bag up to 78% at 0 incubation time, according to Gojón *et al.* (1998).The values of potentially digestible fraction of dry matter (b) obtained in the current diets that included the alga (59% to 64%) are similar to those reported by Galina *et al.* (2004) for diets that included maize, fish flour, and urea (59%) and higher than those found by Ramírez *et al.* (2000) in nine shrubs from Northwest Mexico supplied to sheep (15.5% to 54.7%). In addition to the results obtained by Mora *et al.* (2009) when goats were fed diets containing 10%, 20%, and 30% of the algae M. pyrifera (61 to 64%).The degradable fraction of the diets used in this experiment ranged from 70% to 80%, with no discernible differences between them. This may be connected to Macroystis's high ash and soluble carbohydrate content (Mora *et al.* 2009).In contrast to the rates of 0.05/hr and 0.08/hr, the highest values of effective degradation were obtained at a disappearance or passage rate (fraction/hr) of 0.03/hr. These results are similar to those obtained by Mora *et al.* (2009) with a diet containing M. pyrifera supplied to goats. Forbes (1995) mentions that digestibility is the product of the retention time, so a slower flow allows the feed to have a longer retention time in the rumen, leading to a better degradation. Nonetheless, the presence of algae, regardless of its percentage, improved DM, OM, or CPED (effective degradability of crude protein), and this benefit grew as the amount of algae increased.

Apparent digestibility coefficients:

It is possible that the addition of algae alone or in combination with sunflower oil enhanced the digestibility (Table 6) because these substances contain vitamins, minerals, fatty acids, and amino acids that encourage the fermentation process of rumen microorganisms. These findings were in line with those of Turner *et al.* (2002), who used small amounts of algae in animal and aquaculture feeds. In addition, algae have been linked to enhanced immune system function, lipid metabolism, stress resistance, viral and bacterial activity, improved gut function, and vitamins and minerals in addition to protein, amino acids, fatty acids, and other biologically active photochemical (Güroy *et al*., 2010; Michels *et al*., 2011 andSheikhzadeh *et al*., 2012).

Table 6. Digestion coefficients of experimental rations fed to sheep (Mean±SE).

Item	T1	T2	T3	T4	T5
Digestion coefficients (%)					
DM	59.36±0.53 ^{c}	64.62±0.64 ^{a}	62.77±0.47 ^{b}	62.58±0.63^{b}	64.19±0.38 ^{a}
OM	62.33±0.31 ^{c}	65.97±0.37 ^{a}	63.33±0.16 ^{b}	63.39±0.22 ^{b}	65.75±0.41 ^{a}
CP	59.06±0.37 ^{c}	62.85±0.21 ^{a}	60.83±0.29 ^{b}	60.48±0.11 ^{b}	62.57±0.39 ^{a}
CF	55.43±1.64 ^{b}	58.53±1.21 ^{a}	57.82±1.74 ^{a}	57.58±1.97 ^{a}	58.63±1.89 ^{a}
EE	68.44±1.42 ^{b}	72.37±1.16 ^{a}	72.11±1.26 ^{a}	72.04±1.77 ^{a}	72.18±1.33 ^{a}
NFE	64.66±1.53 ^{c}	71.86±1.33 ^{a}	69.77±0.73 ^{b}	69.82±0.68 ^{b}	71.66±0.63 ^{a}
Cell wall constituents, %					
NDF	57.32±1.08 ^{b}	59.87±0.48 ^{a}	58.94±1.44 ^{a}	59.04±1.29 ^{a}	59.54±1.55 ^{a}
ADF	51.47±0.43 ^{b}	54.34±0.62 ^{a}	53.05±1.31 ^{a}	53.26±1.22 ^{a}	54.12±0.88 ^{a}
ADL	34.27±1.39 ^{b}	37.97±0.97 ^{a}	36.76±0.57 ^{a}	36.56±0.47 ^{a}	37.32±1.76 ^{a}

^{a,b,c}:Means within rows with different superscript are significantly differ (P<0.05).

It is unclear exactly how algae could increase the rumen's cellulolytic activity, but higher fiber digestibility in the ration containing the algae may have resulted from increased rumen cellulolytic activity. According to El-Ashry *et al*. (2003), biological treatments involving various fungal strains resulted in a decrease in the cell wall components of various crop residues. On cell wall content digestibility, however, supplementation with either oils (sunflower or linseed) alone or with algae had negligible (P<0.05) effects, though they were significantly more (P<0.05) than the control. However, compared to those containing sunflower oil plus algae or algae alone, the presence of linseed oil showed a reduction in the digestibility of nutrients, albeit still higher than the control. Algal inclusion resulted in high OM digestion, but other studies found that OM digestibility decreased at inclusion levels greater than 10% (Kinley*et al*., 2016; Ramin*et al*., 2019).It is evident that adding algae, even at the 8% level, had no effect on feed disappearance but rather linearly increased nutrient digestibility. According to Belanch *et al*. (2016), levels up to 5% had no effect on feed disappearance; in a similar vein, Chaji *et al.* (2020) corroborated these findings as finishing buffaloes' nutrient digestibility increased. Meanwhile, phlorotannine (PT) did not inhibit the bacteria that break down fiber. This could be because PT was less concentrated after being sun-dried from algae before being added to diets, which did not actually lower the activity of rumen bacteria (Kinley *et al*., 2016).

Phlorotannine (PT) has been found in algae at varying levels (Li *et al*., 2011). This compound has been shown to increase protein metabolism (Mueller -Harvey and Irene, 2006) and reduce total gas production, and consequently CH4. However, when included at a level > 5% of ruminant DM intake, they are also linked to anti-nutritional effects (Abbott *et al.*, 2020), which the current study confirmed

(Table, 5).In the interim, the existence of PTs may lead to the inhibition of certain enzymes, specifically α-amylase and glycosidase, which are important for the breakdown of complex carbohydrates and, consequently, fiber (Li *et al.*, 2011). This would account for the observed anti-nutritional effect when algae are added at a level greater than 5%. Contrary to what Abbott *et al.* (2020) reported, the present study shows that the PTs content of algae used in diets has no effect on the digestion of fiber.

Feed intake:

Table (7) displays the average daily feed intake of sheep fed with various treatments. When compared to other groups, the addition of marine algae, sunflower oil, and linseed oil to the animal rations had no discernible effect on CFM, fresh berseem, or rice straw intake. During the trial period, the feeding of sunflower oil, linseed oil, and marine algae supplementation did not significantly impact the sheep's overall performance.

The total amount of feed consumed by sheep, as well as the average daily intake of CFM, Berseem, rice straw, and other feed from the various rations, were all relatively similar (P>0.05). On the other hand, Table 6 indicates that the control group had the lowest average daily feed intake (P<0.05), while TDN and DCP with the algae addition had the highest intake. These might be explained by the increased TDN and DCP values of rations including algae, which are the outcome of increased nutrient digestibility overall, as indicated in Table (4). The findings of Begum and Akhter (2010), who discovered that mineral supplementation had no effect on dry matter intake, are not entirely consistent with these results. According to Spiers *et al.* (2004), algae had no impact on the amount of feed that growing steers consumed. On the other hand, feed intake was noted to be intermediate when oils were added alone. It has been demonstrated that adding fat, such as sunflower seeds, to sheep's diets reduces their intake of dry matter (Stegeman *et al.* 1992). According to Schingoethe *et al.* (1996), feeding different fats had no effect on the amount of dry matter ingested. Most studies found that supplementing dairy cows with 200–400 g/d of fish oil reduced their consumption of dry matter (Cant *et al.* 1997). While amounts supplemented were smaller than in other research, Spain *et al.* (1995) found no effect of giving fish oil or ruminal infusion of fish oil on dry matter consumption. It is unclear if the decline in intake was caused by a decrease in the algae diets' palatability, an increase in fat intake, or an intake of specific fatty acids; still, the study's diets' overall fat content did not differ significantly. The concentrate: roughages ratios of the different rations showed negligible differences (P>0.05), which may have something to do with the nearly identical TDN intake of those rations.

Table 7. Average daily feed intake (g/h/d) for sheep fed different rations during a digestion experiment (Mean±SE).

Item	T1	T2	T3	T4	T5
			Average daily feed intake, g/h/d		
CFM	764.74±9.36	766.16±5.85	773.03±7.95	766.69±9.44	768.12±10.11
Berseem fresh	377.64±12.55	377.71±9.45	379.38±8.93	375.68±11.23	378.71±8.55
Rice straw	246.21±33.91	209.06±22.55	216.14±29.88	213.47±19.51	214.30±22.71
Total feed intake	1388.59±11.48	1352.93±14.64	1368.55±8.66	1355.84±19.50	1361.13±15.11
C : R ratio	57.12 : 42.88	56.63 : 43.37	56.49 : 43.51	56.55 : 43.45	56.43 : 43.57

Nutritive values and nitrogen utilization:

The ration with SNF oil (2%) and algae (2%) had significantly (P<0.05) higher TDN value (Table 8) followed by other oil supplementation. While the control one had less (P<0.05) TDN value. This was reflected on TDN intake as well. According to biologists, when amino acids and minerals are absorbed by the rumen, they may improve the microbial activity which in turn could raise the amount of TDN that is accessible from the diet. When feeding value expressed as DCP, ration contained only algae (8%) was recorded the higher (P<0.05) DCP value. The lower (P<0.05) one was noticed with LNS supplementation, while the lowest (P<0.05) was found with the control ration.DCP intake followed its DCP values as well. These results are reflected from degradation of DM, OM and CP of the experimental rations, the efficiency of degradations are in favor of rations containing sunflower oil with algae or seaweed only. According to Ead *et al.* (2011), supplementing dairy cows with algae increased the TDN% and DCP%. Meantime, results of Belanch *et al.* (2016) found that the PTs content in algae has an positive effect on an increase in protein metabolism, which corroborate with the feeding values in this study.

Table 8. Nutritive values and nitrogen utilization of experimental rations fed to sheep (Mean±SE).

Item	T1	T2	T3	T4	T5
Nutritive values .					
TDN, %	57.80±0.51 ^{c}	62.97±0.18 ^{a}	60.83±0.16 ^{b}	61.31±0.42 ^{b}	61.48±0.22 ^{b}
TDN intake (g/h/d)	802.60±3.71 ^{d}	851.35±3.69 ^{a}	832.48±5.48 ^{b}	831.26±6.53 ^{b}	836.82±3.42 ^{b}
DCP, %	7.66±0.13 ^{d}	8.45±0.10 ^{b}	8.44±0.15 ^{b}	8.12±0.16 ^{c}	9.26±0.09 ^{a}
DCP intake (g/h/d)	106.36±0.81 ^{d}	114.32±0.58 ^{b}	115.50±0.74 ^{b}	110.09±0.66 ^{c}	126.04±0.73 ^{a}
Nitrogen utilization					
NI	27.81±0.46	27.56±0.39	27.98±0.22	27.65±0.49	27.75±0.33
NA	16.21±0.21 ^{c}	18.37±0.11 ^{a}	17.25±0.22 ^{b}	17.48±0.18 ^{b}	18.42±0.22 ^{a}
NB	7.11±0.11 ^{c}	8.71±0.24 ^{a}	7.72±0.31 ^{b}	7.67±0.23 ^{b}	8.66±0.19 ^{a}
NBI	25.57±0.21 ^{c}	31.60±0.44 ^{a}	27.59±0.15 ^{b}	27.74±0.14 ^{b}	31.21±0.45 ^{a}
NBA	43.86±0.24 ^{b}	47.41±0.33 ^{a}	44.75±1.19 ^{b}	43.88±0.87 ^{b}	47.01±0.42 ^{a}

$^{a,b,c,and\ d:}$ Means within rows with different superscript are significantlydiffer (P<0.05).

TDN = Total digestible nutrients. DCP = Digestible crude protein. NI = Nitrogen intake.
NA = Nitrogen absorbed. NB = Nitrogen balance. NBI = NB as percentage of NI. NBA = NB as percentage of NA.

Based on the results of nitrogen utilization, there was no significant difference (P>0.05) in the amount of nitrogen consumed by the experimental rations (Table, 6). It was observed that the ration supplemented with algae had

significantly higher (P<0.05) levels of absorbed nitrogen (NA), nitrogen balance (NB), and NB/NA as a percentage of nitrogen intake (NB/NI) than the control one. Although the results for those who only received linseed oil supplementation were in the middle, they were still considerably better (P<0.05) than the control ration. All experimental rations, however, ranged from 7.11 (control) to 8.71 (sunflower oil + algae) and had a positive nitrogen balance.

CONCLUSION

In summary, research has demonstrated that adding plant oils to an animal's diet can improve its digestive system. Algae supplementation has a greater amount of digestion than linseed oil supplementation, even though sunflower oil alone has a positive impact on digestion. If sunflower oil isn't available, linseed oil might be a good substitute; in the interim, it's still preferable to unsupplementation.

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تقييم تأثير إضافة مصادر نباتية طبيعية للأحماض الدهنية غير المشبعة بدون أو مع الطحالب على الهضم في الأغنام

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الملخص

فى تجربة لتقدير تأثير إضافة المصادر النباتيه للأحماض الدهنية غير المشبعة على أداء الاغنام تم عمل ١٦ تركيبة تحتوى على زيت دوار الشمس ، زيت الكتان ، الطحالب البحرية وتم تقدير إختفاء كل من المادة الجافة والعضوية والبروتين وكفاءة التحلل فى الكرش. وقد سجلت الطحالب (٨٪) بدون إضافات أومخلوط الطحالب (٢٪) مع دوار الشمس (٢٪) أعلى معدل لإختفاء المادة الجافة والعضوية وإن كانوا اقل كفاءة فى تحلل البروتين. وبناء على تلك النتائج تم إختيار أفضل اربع تراكيب لتكوين علائق TMR بالاضافة الي العليقة الكنترول لتقدير معاملات الهضم والقيمة الغذائية عند تغذيتها للأغنام كما يلى: ١) عليقه المقارنه (٦٠٪علف مركز و ٤٠٪ برسيم وقش الارز) ٢) مجموعه المقارنه + ٢٪ زيت دوار الشمس + ٢% طحالب. ٣) المقارنه + ١٪ زيت دوار الشمس + ١٪ زيت الكتان + ٤٪ طحالب. ٤) المقارنه + ٢٪ زيت الكتان + ٢٪ طحالب . ٥) المقارنه + ٨٪ طحالب.أظهرت النتائج أن العليقة الثانية و الخامسة سجلتا أعلى كفاءة فى تحلل المادة الجافة والعضوية بالكرش فى حين عليقة زيت دوار الشمس مع الطحالب سجلت أعلى قيمة غذائية (TDN) وأعلى استفادة من نيتروجين العليقة تلاهم العليقة الرابعة وكانت أقل القيم مع عليقة المقارنة.وعليه يمكن إستنتاج أن إضافة زيت دوار الشمس مع الطحالب له إستفادة كبيرة على الهضم فى الأغنام تلاه زيت الكتان والذى يعتبر بديل جيد لزيت دوار الشمس فى حالة عدم توفر الأخير.