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EVALUATION OF UNCONVENTIONAL SILAGE MAKING USING PLANT AND ANIMAL WASTES IN FEEDING RUMINANTS

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ABSTRACT

Laying manure (LM) was added at 35% to plant crops and by-products to formulate 8 different types of complete silages. By evaluating these silages with Zaraibi bucks, it was noticed that the tested silage containing 30% carrot aerial parts (CAP) plus 30% clover was of the lowest quality. Whereas that containing 30% mallow aerial parts + 30% CAP was of the lowest consumption and the quickly damage. But those containing 60% potato aerial parts or 60% sugar beat aerial parts were the best concerning feed consumption (for their high quality), digestibility, and feeding value, which consequently was reflected positively on the rumen and blood parameters. Therefore, it is recommended to make more usefulness of field wastes (particularly from potato and sugar beat) and poultry farms by making high-quality silage of complete feeding value required for ruminants.

Keywords: Goats – silage – Mallow leaves – Carrot leaves – Clover – Potato leaves – Layer manure.

INTRODUCTION

Because of the local increasing demand for animal feeds, besides multiple environmental pollution with variable sources of wastes, it is frequently recommended to recycle these wastes in livestock feeding to be convert into edible animal products, and to overcome the nutritional gap facing the animals (Adelhamid, 1988, 1992 and 2000). Silage making is an important and useful way of preserving and converting agricultural and agro-industrial wastes into good animal feed resources (Lashein *et al*., 1995; Abd El-Baki *et al*., 1997; Karabulut *et al*., 1997 and Mohamed *et al.*, 2000). However, ensilage was known before date in ancient Egypt (Holzschuh and Schmidt, 1963). The present research was designed to evaluate eight integrated diets (silages) by Zaraibi bucks. These silages consisted of plant and animal wastes.

MATERIALS AND METHODS

Experimental animals:

Eight digestibility trials, each on 3 Zaraibi bucks of 3 years old and about 50 kg body weight, were carried out in metabolic cages for one-week collection period after a 28 days preliminary period on floor.

Experimental diets:

Eight diets were formulated as follow:

1- 35% laying manure (LM) + 30% mallow aerial parts (MAP) + 30% carrot aerial parts (CAP) + 5% molasses (M).
2- 35% LM + 60% CAP + 5% M.
3- 35% LM + 30% CAP + 30% clover (C) + 5% M.
4- 35% LM + 30% CAP + 30% sugar beat aerial parts (SBAP) + 5% M.
5- 35% LM + 60 % SBAP + 5% M.
6- 35% LM + 15% MAP + 15% CAP + 15% C + 15% SBAP + 5% M.
7- 35% LM + 30% C + 30% SBAP + 5% M.
8- 35% LM + 60% potato aerial parts (PAP) + 5% M.

Poultry manure without litter from laying housed in 3-floors battery cages was given by the United Poultry Farm, Gamasa. Whereas MAP, CAP, C, SBAP and PAP were freshly collected from Faraskor, Dekerness, El-Serw, Faraskor, and Talkha, respectively. Sugarcane M. was obtained from Besendelah Feed Mill, Belkas. All green ingredients were chopped to 2-4 cm using chopping machine, then wilted by spreading under direct sun for a day. Also, LM was sun-wilted and manually ground. Eight concrete sandwich pits covered with plastic sheets were used, each (6 $\times$ 2 m) was filled with one of the eight experimental diets (integrated silages), where chopped-wilted forages were mixed with wilted LM and sprayed with M/water (1/2). Contents of each pit were feet-pressed within the plastic sheets and covered well with the sheets' edges, then re-pressed with soil, straw bales and concrete blocks. The ensiling; lasted for about 60 days; thereafter, the biweekly required quantities were taken and kept in sealed plastic bags for daily consumption, whereas the pits were tightly re-sealed.

Digestibility trials:

The experimental diets were offered gradually and *ad libitum* for a 15-day transitory period followed by a preliminary period, during which the actual feed intake was estimated to offer only 90% of the satiation limit (to avoid residual feed) during the following collection period. The diets were offered at two equal meals, namely at 8 am and 3 pm, whereas water was available all the time.

Criteria measured:

Besides body weight, feed intake and water consumption, different nutrients digestibility and feeding value were calculated according to Schneider and Flatt (1975). One day later each digestion trial, rumen liquor samples were collected at different intervals from all animals via stomach tube during three successive days. The collected rumen fluid samples were filtered through three layers of gauze for ruminal parameters. Thereafter, blood samples from the jugular vein were withdrawn, 3-hours post-feeding, from all animals. Each blood sample was divided into two parts, one was centrifuged for serum separation, which immediately stored at .20 ^{o}C until biochemical analyses and the other part was heparinized for direct hematological determinations. Proximate analyses of all ingredients, integrated diets, and feces beside silage ammonia were carried out according to AOAC (1990). Cell wall constituents (CWC) including neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were determined after Van Soest (1963) and Van Soest and Wine (1967). Hemicellulose and cellulose were calculated by difference (NDF-ADF and ADF – ADL, respectively). Silage pH was measured by pH-meter (Cambridge-90). Total volatile fatty acids (TVFA) of silage were determined by the method of Patel and Mudgal (1974). Oxalic acid determinations were carried out after Pearson (1973) and aflatoxin test according to Abdelhamid (1980). Ruminal pH-values were immediately measured via pH-meter (ORION-20), whereas ruminal ammonia and TVFA were determined according to Conway (1957) and Warner (1964), respectively. Total number of bacteria and fungi in silage samples were counted using the most probable number technique (Cochran, 1950). Blood determinations were carried out using commercial kits.

Statistical analysis:

All data obtained were statistically analyzed using MSTATC software based on Snedecor and Cochran (1981) and Duncan (1955).

RESULTS AND DISCUSSION

Chemical composition of the tested silages:

Table (1) shows that crude fiber (CF) was high in MAP, CAP, and C, whereas crude protein (CP) was high in LM and low in all roughages used particularly CAP. SBAP and PAP contained the highest nitrogen free extract (NFE). The lowest ash content was determined in C, but it was high in all other ingredients particularly SBAP. Table (2) illustrates that dry matter (DM) percentage averaged between 34.9 and 43.1. This means that MAP and SBAP were responsible for the highest DM contents, whereas the mixture (diet No. 6) and C containing silages (diets No. 3 and 7) reflected the lowest DM %. Yet, both later diets (No. 3 and 7) contained the highest organic matter (OM) percentages. However, the lowest OM % and highest ash % were recorded for diet No. 5. The highest OM in diets No. 3 and 7 was accompanied also with the highest CF in diet No. 3 and CP in diets No. 3 and 7, but with the lowest ether extract (EE) and ash percentages in diets No. 3 and 7, respectively. On the other hand, the lowest OM in diet No. 5 was accompanied also with the lowest CF and the highest EE content. However, the highest NFE was determined in diet No. 8 followed by diet No. 5, whereas the lowest were in diets No. 2 and 1, respectively. Table (2) shows also CWC of the tested silages, where diet No. 7 gave the highest NDF% and ADF %, whereas the lowest were estimated for diet No. 8. ADL % was the highest in diet No. 1 and the lowest was in diet No. 8. Diet No. 7 contained also the highest content of hemicellulose but the lowest was in diet No. 1. The highest and the lowest cellulose contents were recorded in diets No. 3 and 8, respectively. Anyhow, variations in chemical composition of different agricultural wastes were reported before (Abdelhamid *et al.,* 1992). Thus, they recommended using these wastes in ruminants feeding but after improving their nutritive value (minerals and protein). Also, Rude and Rankins (1993) found that CP and mineral contents in forage could be enhanced by adding poultry litter. The obtained results of diet No. 5 are similar to those found by Bendary *et al*. (1999), except their higher CF % and lower CP %. But the findings of Mohiel-*Din et al.* (2000) are lower than those reported herein, except for EE, NFE and ash percentages.

Table 1: Chemical analysis (% on dry matter basis) of the experimental feed ingredients

Item	DM	OM	CF	CP	EE	NFE	Ash
MAP	22.1	78.3	21.0	13.5	2.90	40.9	21.7
CAP	26.8	78.5	23.9	10.8	2.65	41.2	21.5
C	17.7	89.6	27.0	14.7	2.09	45.8	10.4
SBAP	12.5	77.2	12.5	12.9	2.40	49.4	22.8
PAP	24.6	79.1	13.7	11.6	2.50	51.3	21.0
LM	87.8	80.3	10.5	29.5	2.50	37.8	19.7
M	65.3	81.5	---	3.83	---	77.7	18.5

Table 2: Chemical analysis (% on dry matter basis), microbial count (live cells/gram) and quality parameters of the tested silages

Chemical composition	Dietary treatments No.							
	1	2	3	4	5	6	7	8
DM	42.7	39.6	38.2	41.5	43.1	34.9	35.2	40.9
OM	79.0	79.3	82.8	78.3	77.7	78.6	81.9	79.1
CF	17.8	18.9	19.7	15.6	12.2	15.1	16.5	12.4
CP	16.6	15.9	17.0	16.2	16.3	16.7	17.3	16.5
EE	2.83	2.73	2.55	2.77	2.85	2.75	2.59	2.63
NFE	41.8	41.8	43.6	43.7	46.4	44.1	45.5	47.6
Ash	21.0	20.7	17.2	21.7	22.3	21.4	18.2	20.9
NDF	38.9	35.2	40.9	34.4	34.1	39.2	41.0	33.9
ADF	31.9	26.6	33.3	27.0	26.8	30.8	32.0	25.3
ADL	6.50	5.97	6.07	5.83	5.67	6.02	6.25	5.57
Hemicellulose	7.0	8.6	7.6	7.4	7.3	8.4	9.0	8.6
Cellulose	25.4	20.6	27.2	21.2	21.1	24.8	25.8	19.7
Fungi	4	---	12	---	---	35	---	8
Bacteria	30	140	98	146	84	304	166	68
pH value	4.90	4.97	5.31	4.69	4.51	4.60	4.79	4.57
Lactic acid, mg/100g	1.65	1.60	1.45	1.95	2.20	2.05	2.00	2.10
TVFA, meq/100g	17.0	15.5	13.7	19.5	21.8	20.5	19.4	20.5
Ammonia-N, mg/100g	23.7	22.3	28.5	19.9	18.2	19.5	20.5	18.5
Oxalic acid, % (DM basis)	3.22	5.79	3.35	7.19	9.25	4.05	4.70	---

Silage quality:

Concerning the organoleptic tests, all silages tested were green-olive colored (except diet No. 3 was darker), normal moist (except diets No. 5 and 8 were more moist), normal odor (except diets No. 5 and 8 were aromatic), and solid (except diets No. 5 and 8 were somewhat soft). However, the high level used of LM decreased the homogenecity with the roughages used. Yet, Chaudhry *et al.* (1996) indicated that poultry litter could be incorporated into diet of ruminants at levels of up to 50%. The normal silage smell was volatile acids, except diets No. 5 and 8 were sweet-desirable whey for their high NFE contents. Table (2) presents also quality parameters of the tested silages, where pH values were lower than 5, except for diet No. 3, which reflected also the lowest level of lactic acid and TVFA and the highest ammonia concentration reflecting the lowest quality silage among all tested ones. Generally, weather may affect silage fermentation (Mc Cullough, 1978). The highest acceptable pH value in silage is 5.0 (Meyer *et al*., 1980). Additionally, increasing ammonia and pH value in a silage are indicator for poor quality silage (Flynn, 1988). After about one year preservation, diet No. 6 only was contaminated with 452 ppb aflatoxin B_1 may be because of aeration which enable moulding and spoilage (Cullison, 1982) as well as for its high moisture content which is suitable for fungal and bacterial invasion (Table 2) as reported before by Abdelahmid *et al*. (1985). Table (2) shows also that diet No. 8 (including PAP) was free of oxalic acid. Meanwhile, all other silages contained oxalic acid at high levels, particularly those contained SBAP (diets No. 5 and 4) or CAP (diet No. 2). Mohiel-Din (1998) reported also percentage of oxalic acid in a silage of SBAP + poultry litter as 4.05 % on fresh basis, whereas it was 4.84 % in SBAP silage. This means that the addition of poultry litter to a silage will reduce its total content of oxalic acid.

Feed and water consumption:

Table (3) shows that bucks consumed significantly ($P \leq 0.01$) more fresh silages of diets No. 6 and 8 than the others; yet, diets No. 8 and 5 were consumed at the highest level based on DM. Also, diet No. 8 led to the highest water consumption, whether as ml/h/d or ml/kg $w^{0.82}$. But the animals fed on diet N0. 7 consumed the highest quantity of water as ml/g DM intake, this perhaps attributed to its highest CP content (Sultan, 1995). However, and in accordance with the obtained results herein, Kim and Kim (1983) indicated that intake of silage containing 20% poultry droppings by Korean native goats was low. Therefore, Shamma and Athari (1987) recorded greater DM intake of silage with 10% poultry litter than with 20%. Since there was an indication of possible difficulties in getting animals to consume much of a diet containing poultry litter silage (Griffith, 1993), particularly with low phosphorus containing roughages as in Egypt (Abdelhamid *et al*., 1992).

Digestibility and feeding value:

As presented in Table (3), it is clear that all nutrients digestibility were significantly higher for diets No. 6 and 8 than the other diets. Also, diet No. 8 reflected the best total digestible nutrients (TDN) and starch equivalent (SE), whereas diet No. 7 gave the best digestible crude protein (DCP), perhaps for its highest CP content. However, all silages contained CAP (diets N0. 1, 2, 3 and 4) reflected lowest digestion coefficients of one or more of the nutrients and consequently also lowest feeding value. Regardless to silage type, the highest digestibility coefficients were calculated for EE, CP and NFE in a descending order, whereas the lowest was CF digestibility. The obtained results are in agreement with those given by Schneider and Flatt (1975) concerning increased CF digestibility by increasing CF content of poor roughages. Also, in accordance with the obtained results, Sultan (1995) found that increased C proportion in the silages led to increased digestibility of NFE and decreased those of CP, EE and CF. Additionally, Abd El-Baki *et al.* (1997) concluded that increasing SBAP in the silages increased their digestibility and feeding value. However, Abdelhamid and Topps (1991) found that digestibility of a silage is affected by silage quality, presence of concentrates, length of adaptation period, and previous feeding.

Cost of silage production:

According to the prevailing prices and from Table (3) it is clear that the cheapest silage was that of diets No. 5 and/or 8. However, all tested silages were cheaper than whole maize plant silage (100-130 L.E/ton fresh basis) under the same circumstances. In this direction, Trung (1988) indicated that poultry manure offers an opportunity to save on feed costs. However, the economical advances are dependent on silage type (Rude and Rankins, 1993).

Table 3: Means of feed intake, water consumption, digestibility coefficients, nutritive value and cost* of the tested silages by Zaraibi bucks

Chemical composition	Dietary treatments No.							
	1	2	3	4	5	6	7	8
Feed intake								
Fresh, g/h/d	2000^{E}	2100^{DE}	2000^{E}	2175^{CD}	2300^{BC}	2585^{A}	2350^{B}	2500^{A}
DM, g/h/d	845^{BC}	832^{C}	765^{D}	904^{B}	992^{A}	903^{B}	828^{C}	1023^{A}
DM, g/kg$W^{0.75}$	43.5^{DE}	45.0^{D}	41.3^{E}	47.0^{CD}	51.4^{AB}	49.1^{BC}	46.1^{CD}	53.6^{A}
DM, % of BW	1.60^{EF}	1.70^{DE}	1.56^{F}	1.76^{CD}	1.92^{AB}	1.86^{BC}	1.76^{CD}	2.01^{A}
Water consumption								
Ml/h/d	1350^{F}	1400^{EF}	1150^{G}	1500^{DE}	1700^{B}	1550^{CD}	1675^{BC}	1875^{A}
Ml/kg $W^{0.82}$	51.6^{E}	57.5^{D}	47.3^{E}	59.2^{D}	66.9^{BC}	64.3^{C}	71.3^{AB}	74.6^{A}
Ml/g DM intake	1.58^{CD}	1.68^{BCD}	1.50^{D}	1.66^{BCD}	1.71^{BC}	1.72^{BC}	2.03^{A}	1.83^{B}
Digestion coefficients, %								
DM	45.4^{E}	55.5^{D}	54.0^{E}	57.9^{C}	58.8^{B}	59.7^{A}	58.0^{C}	59.6^{A}
OM	54.1^{E}	54.7^{DE}	55.4^{D}	56.6^{C}	58.7^{B}	59.5^{AB}	58.9^{AB}	59.7^{A}
CF	41.5^{AB}	41.4^{AB}	42.4^{AB}	40.5^{B}	41.5^{AB}	44.1^{A}	42.9^{AB}	42.4^{AB}
CP	62.8^{D}	63.7^{CD}	64.2^{CD}	65.5^{BC}	65.6^{BC}	67.7^{A}	66.4^{AB}	66.9^{AB}
EE	69.4^{BC}	69.0^{C}	66.4^{E}	70.1^{B}	72.2^{A}	71.3^{A}	67.8^{D}	69.4^{BC}
NFE	55.0^{E}	56.3^{D}	57.2^{D}	59.0^{C}	60.0^{BC}	60.9^{AB}	61.4^{AB}	61.6^{A}
Nutritive value, % (DM basis)								
TDN	45.2^{D}	46.0^{CD}	48.0^{AB}	47.7^{BC}	48.5^{AB}	49.2^{AB}	48.4^{AB}	50.0^{A}
SE	33.5^{E}	33.5^{E}	35.4^{D}	37.4^{C}	39.8^{B}	38.2^{C}	39.5^{B}	41.6^{A}
DCP	10.4^{CD}	10.2^{D}	10.9^{B}	10.6^{BC}	10.7^{BC}	11.3^{A}	11.5^{A}	11.4^{A}
Cost,								
L.E./ton fresh	47.0	53.0	56.0	47.0	41.0	48.5	50.0	41.0

A-F: Means in the same row superscripted by different letters significantly ($P \leq 0.01$) differ.
***: It dependents on the prevailing prices of (as fed) carrot tops, sugar beet tops, potato tops, mallow, berseem, layer manure and molasses, being 40, 20, 20, 20, 50, 40 and 300 LE/ton, respectively.**

Rumen liquor parameters:

Figures 1 to 3 illustrate mean values of ruminal pH, ammonia-N (NH_3-N), and TVFA of Zaraibi bucks fed the experimental complete silages. Although NH_3-N concentrations gradually decreased by sampling time till the

6^{th} hour, the pH values decreased only till the 4^{th} hour, but on the opposite, TVFA level gradually increased till the 4^{th} hour. The normal relationships of rumen parameters were realized, since there were positive relation between pH value and NH_3-N concentration but negative relation between TVFA levels on one side and either of pH value or NH_3-N concentration on the other side. However, all tested silages were good fermented in the rumen.

Table 4: Means of blood parameters for Zaraibi bucks fed the tested silages

Items	Dietary treatments No.							
	1	2	3	4	5	6	7	8
Hemoglobin, Hb, g/dl	7.90^{CD}	8.20^{BCD}	7.80^{D}	8.83^{B}	9.03^{B}	9.90^{A}	9.03^{AB}	8.73^{BC}
Red blood cells, RBC_s, $X10^6/\mu l$	9.66^{BC}	10.1^{ABC}	9.43^{C}	11.1^{A}	11.0^{AB}	11.5^{A}	11.1^{A}	11.3^{A}
Hematocrit, Hct, %	24.4^{B}	25.0^{B}	24.6^{B}	26.9^{A}	26.9^{A}	27.5^{A}	26.7^{A}	26.5^{A}
Glucose, mg/dl	63.7	65.4	64.2	65.9	66.2	65.7	66.4	66.6
Total lipids, mg/dl	355	342	360	337	330	335	337	330
Cholesterol, mg/dl	108^{AB}	104^{ABC}	109^{A}	103^{ABC}	99.3^{ABC}	94.0^{C}	102^{ABC}	98.3^{BC}
Bilirubin, mg/dl	0.32^{AB}	0.32^{AB}	0.39^{A}	0.33^{AB}	0.27^{B}	0.27^{B}	0.25^{B}	0.26^{B}
GOT, u/l	53.0	53.0	54.3	54.0	52.0	51.0	54.3	56.0
GPT, u/l	15.9	15.2	16.7	15.5	15.6	15.0	14.6	15.3
Total protein, g/dl	6.40	6.50	6.30	6.40	6.45	6.50	6.50	6.55
Albumin, A, g/dl	3.27	3.37	3.33	3.33	3.17	3.23	3.20	3.17
Globulin, G, g/dl	3.13^{BC}	3.13^{BC}	2.97^{C}	3.07^{BC}	3.28^{AB}	3.27^{AB}	3.30^{AB}	3.38^{A}
A/G ratio	1.04^{AB}	1.08^{AB}	1.13^{A}	1.09^{AB}	0.96^{B}	0.99^{AB}	0.97^{B}	0.94^{B}
Urea-N, mg/dl	18.0	17.5	17.8	17.7	17.3	19.1	18.9	19.0
Creatinine, mg/dl	1.63^{AB}	1.83^{AB}	1.73^{A}	1.43^{B}	1.53^{AB}	1.50^{B}	1.43^{B}	1.50^{B}
Calcium, mg/dl	9.80	9.93	9.70	9.90	10.4	10.6	10.3	10.4
Phosphorus, mg/dl	5.40	5.60	5.33	5.43	5.70	5.73	5.53	5.33
Magnesium, mg/dl	3.10^{B}	3.30^{AB}	3.03^{B}	3.33^{AB}	3.40^{AB}	3.53^{A}	3.40^{AB}	3.40^{AB}
Iron, $\mu g/dl$	73.0^{C}	75.3^{BC}	72.3^{C}	79.3^{AB}	83.0^{A}	84.3^{A}	82.0^{A}	83.3^{A}
Oxalic acid, g/dl	0.55	0.87	0.59	1.19	1.62	0.67	0.78	---

A-D: Means in the same row superscripted by different letters significantly ($P \leq 0.01$) differ.

Blood profile:

The only significant effects on blood parameters due to feeding Zaraibi bucks on the tested silages were restricted in the hematological parameters (Hb, RBCs and Hct) besides some of liver (cholesterol and bilirubin) and kidney (G, A/G ratio and creatinine) functions and some electrolites (Mg and Fe). Since diet No. 6 reflected the highest Hb, RBCs, Hct, Mg and Fe but the lowest cholesterol values (Table 4). However, all the obtained values of different parameters measured were within the normal ranges reported by Jain (1986) and Kaneko (1989). This confirms that there were no deleterious effects of feeding bucks on different silages. Although there were relatively increased values for cholesterol, creatinine and A/G ratio for bucks fed on diets No. 1, 2 and 3 than the other animal groups fed on the other silages. However, Abdelhamid *et al*. (1999 a and b) reported nearly similar values for Zaraibi goats. Additionally, Yildiz *et al*. (1998) mentioned that blood parameters were not affected in rams fed diets containing 10 – 15% poultry fig

litter plus 10 –15% rumen contents. Although the present results confirm those of Abdel-Raouf *et al*. (2000) who found that silage feeding elevated blood values of Hb, glucose and cholesterol. On the other hand, the high level of oxalic acid in blood of bucks fed on diets No. 5 and 4 is correlated with the high level of this organic acid in both silages (Table 2). Since oxalic acid accumulate in different tissues of animals as found by Abdelhamid and Saleh (2000).

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تقييم عمل السيلاج غير التقليدي باستخدام مخلفات نباتية و حيوانية في تغذية المجترات

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تم إضافة زرق الدجاج البياض بنسبة 35% إلي مخلفات ومحاصيل نباتية مختلفة لعمل ثمانية أنواع من السيلاج المتكامل لتقييمها علي تيوس الزرايبي، فوجد أن السيلاج المحتوي علي 30% عروش جزر + 30% برسيم هو الأسوأ جودة، وأن السيلاج المحتوي علي 30% أوراق خبيزي + 30% عروش جزر هو الأقل استهلاكا والأسرع فساداً، بينما السيلاج المحتوي علي 60% عروش بطاطس أو 60% أوراق بنجر سكر كانت هي الأفضل استهلاكا لارتفاع جودتها وهضمها وقيمتها الغذائية مما انعكس إيجابيا في صورتي الكرش والدم. ومن ثم فإنه ينصح بالاستفادة من مخلفات الحقل (وعلي الأخص من البطاطس وبنجر السكر) ومزارع الدواجن في عمل سيلاج عالي الجودة متكامل القيمة الغذائية المتطلبة للمجترات.