

Evaluation of Some Vegetable Wastes as Feedstuff for Ruminants

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Abstract: This study was carried out to evaluate the potentiality of the waste of beet (*Beta vulgaris*) leaves, carrot (*Daucus carota*), leaves and onion (*Allium cepa*) peel as ruminant feed through chemical composition, estimation of the in sacco study of the dry matter degradability (DMD), and effective dry matter degradability. Using in situ technique. The DM degradation characteristics were done by incubation the sample at (0, 3, 6, 12, 24, 48, 72 and 96 h) in the rumen. The degradation within characteristics varied significant between the wastes. The range of the characteristics was 18.60% in the onion peel to 70.01% in beet for the soluble fraction (a), 28.43% in beet to 79.09% in onion peel for insoluble fraction (b) and 0.04% in onion peel to 0.21% in carrot for degradation rate. The effective degradability (ED) for the studied samples was highest at F (0.02) ranged from 71.80% in onion peel to 91.95% in carrot rumen out flow rate and lowest at (0.08) ranged from 45.52% in onion peel to 86.08% in carrot. For all the wastes major DMD was between 72- 96 incubation times. The results of the studied vegetable wastes showed a good potential as a ruminant feed.

Keywords: Rumen degradability, vegetable waste, nylon bag technique, dry matter degradability, insoluble fraction

1. Introduction

Most of the developing countries have been fighting to provide adequate feed to their livestock, because of inadequate production of conventional ingredients for livestock feeding. The inadequate quantities of concentrated feedstuffs they produce annually are competed for by humans and livestock. So the scarcity of feed sources often imposes a major challenge in livestock production in these countries [1] The challenge can be alleviated by the use of unconventional feedstuffs in animal feeding depending on their nutrient content, availability and acceptability to animals; and provided it is economical compared to conventional feed ingredients. The potential of by-products in animal nutrition has long been identified. Organic waste from markets represents about 10-20% of the total waste of a city. A large proportion comes from the overproduction of vegetables, turning them into potential pollutant. The nutritional value found for vegetable waste from a marketplace, these products might be considered as a potential alternative for animal feeding. The use of fruits-vegetable wastes in animal nutrition has attracted the attention of many researchers, due to the fact that these waste are locally available [9], The biodegradable waste presents high water content (from 60% to 80%) [10], while the dry matter is relatively low [8], rich in nitrogen free extract [10]. [8], reported that vegetable wastes contain 12% crude protein, 13% crude fibre, 8% ash and 2% ether extract. [14], reported dry matter, crude protein, and ash for beet as high as 93.5%, 13.2%, and 9.4%, respectively. Beetroot (*Beta vulgaris*) is botanically classified as an herbaceous biennial from Chenopodiaceae family and has several varieties, beet roots are the most popular for human consumption, both cooked and raw as salad or juice. Beetroots are rich in valuable, active compounds such as carotenoids, glycine betaine, saponins, betacyanines, folates, betanin polyphenols and flavonoids [24], [13] reported the chemical constituents of carrot as moisture (86%), protein (0.9%), fat (0.2%), carbohydrate (10.6%), crude fiber (1.2%), total ash (1.1%), Ca (80 mg/100 g), Fe (2.2 mg/100 g) and p (53 mg/100 g) whereas, the values reported by [24], for most of these

parameters are different i.e. moisture (88.8%), protein (0.7%), fat (0.5%), carbohydrate (6%), total sugars (5.6%), crude fiber (2.4%), Ca (34 mg/100 g), Fe (0.4 mg/100 g), p (25 mg/100 g), Na (40 mg/100 g), K (240 mg/100 g), Mg (9 mg/100 g), Cu (0.02 mg/100 g), Zn (0.2 mg/100 g), carotenes (5.33 mg/100 g), thiamine (0.04 mg/100 g), riboflavin (0.02 mg/100 g), niacin (0.2 mg/100 g), vitamin C (4 mg/100 g) and energy value (126 kJ/100 g).

However, to find out the optimum processing and utilization of such residues as animal feed, the seasonal availability and nutritive value of these by-products should be identified. Therefore, vegetable wastes could serve as an excellent source of nutrients for ruminants and can economize the production of animals [27]. To the best of our knowledge is limited information available on the use of vegetable as animal feed, in the Sudan. So this study was carried out to assess the nutritive value of these waste and to recycle them as ruminants feed and to contribute to the hygiene of the markets.

2. Materials and Methods

The study was conducted at the Farm of College of Animal Production Science and Technology, Sudan University of Science and Technology, Kuku area.

2.1 Collection of Sample

All vegetable waste samples were collected from Khartoum North Central Fruits and Vegetable Market. They were chosen according to the availability of waste during the study period. The collection was performed during the evening after finishing sale of products. Vegetable waste samples were air dried.

2.2 Chemical Analysis

Dry matter (DM) content was determined by drying the samples at 105°C overnight and ash by igniting the samples in muffle furnace at 525°C for 8 hs and crude protein content

was measured by the Kjeldahl method [5]. Ether extracts (EE) were determined by the method of [5] Crude fiber (CF) was determined according to the method of [24]. When crude protein, fat, water, ash, and fiber are added and the sum is subtracted from 100, the difference is NFE = DM - (%Moisture + %CF + %CP + % EE + %Ash).

2.3 Experimental Animals

Three animals of a local breed (Kenana) aged 4-5 and were fitted with rumen cannula as described by Brown, (1968); for the *in situ* study techniques. They were fed a balanced ration of concentrate and roughages to maintenance level with free access to water and salt lick.

2.4 In Situ Study Technique

The nylon bag technique of [20] was employed to measure the DM degradation characteristics of vegetable waste. Samples were milled in a hammer mill through a 3 mm sieve and subjected to standard rumen degradability procedures using three castrated calves of approximately 300 -350 kg live weight. Nylon bags with 35-40 μ pore size containing 5 g samples in duplicate were incubated in each animal for each of the incubation periods: 3, 6, 12, 24, 48, 72 and 96 hours. The bags were removed, after incubation in the rumen, then washed with cold running water until the washing water ran clear and colorless. Zero time samples were not incubated in the rumen, but were washed with running cold water as above to determine their solubility at time 0 h. The bags were oven dried at 72°C for 24 h, then taken out, cooled in a dissector and weighted by sensitive balance. Dry matter disappearance (%) was calculated as follows:

$$\frac{\text{Weight of sample incubated} - \text{Weight of residue after incubation}}{\text{Weight of sample incubated}} \times 100$$

The DM degradation data were fitted to the exponential equation (Qrskov and McDonald, 1979):

$$p = a + b(1 - e^{-ct})$$

P = the disappearance of nutrient during time t.

a = the soluble nutrient fraction which is rapidly washed out of the bags and is assumed to be completely degradable.

b = the proportion of insoluble nutrient, which is potentially degradable by microorganisms.

c = the degradation rate of fraction b per hour.

2.5 Statistical Analysis

The obtained data were subjected to one way (ANOVA) analysis of variance to determine the variation among the studied wastes with regard to DM degradability, degradation kinetics. Significant differences among the samples were assessed using least significant differences (LSD) test according to [12]. The Statistical Package for Social Sciences Program (SPSS), version (10) was used for the analysis.

3. Results

Chemical Composition

Table (1) shows the chemical composition of the vegetable samples waste. The CP content ranged from 7.04% in carrot to 16.28% in beet. The CF ranged from 7.80 % in carrot leaves to 16.00% in beet leaves.

Table 1: Chemical Composition % of the Studied Vegetable Waste:

Components	DM%	CP%	EE%	CF%	Ash%	NFE%
Beet	90.4	16.28	0.8	9.2	11.3	52.82
Beet leaves	96	23.32	1.6	16	11.67	43.41
Carrot	83.9	7.04	1.2	15.4	10.73	49.53
Carrot leaves	95.5	9.35	2.8	7.8	21.16	54.39
Onion peel	91.3	8.66	1	44.5	15.56	21.58

DM: Dry matter

CF: Crude fiber

EE: Ether extract

(OMD): Organic matter digestibility

NFE: Nitrogen Free Extract

ME: Metabolisable energy

CP: Crude protein

(IVDMD): In vitro dry matter digestibility.

Table 2: Values for *in vitro* gas Production (mL/200 mg DM) Times for the Studied Vegetable Waste:

Parameters	Beet (M±SD)	Beet leaves (M±SD)	carrot (M±SD)	Carrot leaves (M±SD)	Onion peel (M±SD)	Significance Level
a	70.01±0.20 ^a	50.47±0.45 ^c	63.42±0.42 ^b	44.30±0.42 ^d	18.60±0.75 ^e	**
b	28.43±0.37 ^e	43.40±0.57 ^c	31.25±0.47 ^d	46.82±0.42 ^b	79.09±0.93 ^a	**
c	0.05±0.00 ^b	0.05±0.01 ^b	0.21±0.01 ^a	0.05±0.00 ^b	0.04±0.00 ^c	**
a+b	98.44±0.45 ^a	93.88±0.70 ^d	94.67±0.16 ^c	91.13±0.17 ^e	97.70±0.97 ^b	**
ED at F (0.02)	90.28±0.20 ^a	81.49±0.39 ^b	91.95±0.07 ^a	79.54±3.70 ^b	71.80±0.39 ^c	**
ED at F (0.05)	84.17±0.16 ^b	72.19±0.88±0.30 ^c	88.68±0.09 ^a	68.08±0.18 ^d	54.42±0.53 ^e	**
ED at F (0.08)	80.89±0.16	67.19±0.30 ^c	86.08±0.15 ^a	62.66±0.22 ^d	45.52±0.41 ^e	**

M±S: (Mean± standard deviation).

*significantly (P<0.05), **: highly significantly different (p< 0.01)

a,b,c,d,e: Means within the same raw followed by different superscripts are.

a: soluble fraction (wash loss) .

b: degradation of the water insoluble fraction

c: degradation rate

a+b: Potential degradability.

ED: effective degradability at rumen outflow (0.02, 0.05, And 0.08) F: flow rate

Table (2) shows the dry matter degradation kinetics of the vegetable wastes. Beet showed the highest value for a fraction and potential degradability while the carrot showed the highest value for c fractions as well as the effective degradability at all the ruminal outflow rates, while the onion peel exhibited the highest for b fraction which is subjected to degradation for the studied vegetable waste:

4. Discussion

There are many factors affecting chemical composition and mineral content of feed stuffs such as stage of growth, maturity, species or variety, drying method, environment and soil type, [26], [4] and [19]. These factors may partially explain differences in the chemical composition among the studied waste products.

Differences in the dry matter DM content of the samples could be attributed to the differing DM content of beet, beet leaves, carrots, carrot leaves and onion peel. The dry matter DM content in beet, beet leaves, carrot leaves and onion peel were comparable with the results reported by [23] and [19].

The crude protein CP content in beet leaves was similar to that published by [22]. The beet CP content was higher than the results by [11]. The CP content in carrot was higher than that reported by [23]. The crude protein content in onion peel was lower than that reported by [22]. The CP content in carrot, onion peel and carrot leaves were relatively close to that reported by [17], [11], [29], and [22] and highest than that reported by [14]

Ether extract (EE) is also known as crude fat which comprises of all substances that are soluble in ether. Although EE contain lipids, which provide energy it will also include other fat-soluble substances such as chlorophyll and fat-soluble vitamins. [5]. The ether extract (EE) content in carrot leaves in this study is comparable with the result obtained by [23] and [3]. The EE content in onion peel, beet and carrot were relatively close to that reported by [22], [17], [23] and [14].

The nitrogen free extract NFE content in carrot leaves, and beet in this study were close with the results reported by [7]. The NFE content in carrot and beet leaves were in agreement with that reported by [14]. The nitrogen free extract NFE content, represents the highly digestible carbohydrates indicated that they had the highest soluble cell contents. [25].

The crude fiber CF in beet in this study is comparable with the findings reported by [16] and disagree with which reported by Stanton and [24]. The CF in onion peel is close with that reported by [15]. The CF content results in carrot and beet leaves were lower than the reported by [16]. The crude fiber CF content is usually taken as a negative index of feed quality [25]. These include feed resources derived from crops grown for renewable energy such as sugarcane by-products and root crops. Examples of this category would be waste material arising from the fruit processing (citrus pulp waste) and root crops [2].

The ash content in carrot leaves is comparable with that reported by [29]. The ash content in beet, beet leaves, carrot and onion peel were close with the results reported by [7]. The carrot exhibited the highest degradability rate; and this is most probably due to the high solubility of its content, which is inferred from the washing loss at the zero time [29]. Although the carrot leaves and the beet leaves have less crude fiber content than the onion peel but its degradability rate was lower than that of the onion peel. This can be attributed to the difference in the cell wall contents which are most probably got lignified, and lignin is known to resist the microbial breakdown of the cell wall [16]. The beet exhibited the highest Potential degradability than the carrot due to the high solubility of its content, this is inferred from the (a) value, which is washed out quickly resulting in fast degradability rate.

It is summed from this study that vegetable wastes have a potentiality as ruminants' feed supplement; further work should be done to study their digestibility.

5. Conclusion

It was concluded that carrots, carrots leaves, beets, beets' leaves and onion peel have a good potentiality as source of nutrients for ruminants and can economize the production of animals.

6. Recommendations

Investigation of the presence of anti-nutritional factors and heavy metals on the vegetables waste should be done.

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