Proximate composition dried ruminal fluid with spray drying method with various hydrocolloids

ABSTRACT

This study was conducted to determine the chemical and mineral composition of dried ruminal fluid with spray drying method with various hydrocolloids. The values for each of the nutrients were collected in triplicates according to the samples analyzed. The results of mean percentages showed the samples contained moisture (5.8 ± 0.43 to 8.8 ±0.47), crude protein (9.98 ± 0.43 to 13.08 ± 0.43), Ether Extract (1.29 ± 0.51 to 3.29 ± 0.35), Ash (16.30 ± 0.41 to 22.48 ± 0.32), NDF (28.01 ± 0.42 to 24.20 ± 0.19), and carbohydrates (36.90 ± 0.0.26 to 44.80 ± 0.43). The essential minerals were sodium (2.10±0.05 to 4.95±0.02), potassium (0.46 ± 0.03 to 0.76 ± 0.03), magnesium (0.76 ± 0.06 to 0.96 ± 0.06), calcium (0.33 ± 0.09 to 0.65±0.02) and phosphorous (1.22 ± 0.09 to 1.87± 0.08). The results indicated that dried ruminal fluid with spray drying method with various hydrocolloids has nutrition values that could provide nutrients and minerals for livestock. It is recommended in the diet of animals.

KEY WORDS: Proximate composition, Ruminal fluid, Spray drying, Hydrocolloids, Mineral

1. INTRODUCTION

The global shortage of animal feed increases the share of livestock feed costs and the income generated by the production of livestock products has been affected. In order to compensate for this shortage, the utilization and optimal use of agricultural waste and agricultural products as feed in ruminants is inevitable to improve livestock production [1]. Large amounts of rumen content are produced daily as a byproduct in slaughterhouses [2]. These pollutants pollute the environment by releasing toxic gases, including methane, nitrogen dioxide and other gases in the atmosphere [3]. Also, the rumen fluid contains high levels of ammonia and phosphorus [4]. Therefore, rumen fluid is a serious environmental contaminant in most slaughterhouses in developing countries [5]. The contents of the rumen are rich in raw microbial protein and contains forage materials digested in different stages of fermentation, saliva, amino acids, group B vitamins and end products of ruminal fermentation [6], rich in minerals [7]. As well as antiphysiological factor [5]. Sun-dried rumen digesta has been reported to contain 11.18 % crude protein, 22.99 % crude fiber, 1.22 % ether extract, 21.54 % ash, 0.20 % calcium and 0.45 % phosphorous [8]. Sakaba et al. [9] also reported the composition of 5.83 % moisture, 15.52 % crude protein, 5.17 % lipids, 48.17 % fiber, 11.00 % ash, 19.98 % soluble carbohydrate, 19.98 % Sodium, 4.37 % Potassium, 0.42 % magnasium, 0.45 % calcium and 4.37 % phosphprous from sun-dried rumen digesta. The benefits of recycling these first waste reduces environmental pollution, secondly, it is a source of feed for ruminants [3]. With proper processing, the rumen content can provide a large supply of nutrients when it enters the ration [10]. And the protein needs of high-producing animals [11]. Drying can be used as a

solvent reduction, which is usually water, to produce a stable and saveable product [12]. Spray drying is one of the encapsulation methods used to dry the heat-sensitive materials and a simple, quick, and economical technique for obtaining a powder from a solution or a liquid suspenson (such as an enzyme suspension [13]. Some binding agents, such as some disaccharides, are added to the protein and improve sustainability during the build and save process. Many studies have shown the protective effects of connective materials for denaturation [14]. Therefore, some carbohydrates (such as starch, maltodextrin and dextrose), gums (such as Arabic gum, acacia gum, sodium alginate and carrageenans), proteins (such as milk or whey protein, gelatin) and chitosan are used in spray drying methods [15]. So far, no research has been done on the approximate compounds of dried ruminal fluid by spray drying method with different hydrocolloids. This study was conducted to determine the composition of t this substances.

2. MATERIALS AND METHODS

2.1 Sample preparation and spray drying

The rumen contents were taken from the slaughterhouse and was transferred to a lab inside a pre-warmed containers. Then, the ruminal fluid containing digestive material was mixed with a blender for 2 minutes while injected with carbon dioxide gas. In order to separate rumen fluid from rumen solid materials filtration through four-layers cheesecloth was used. Then, The collected rumen fluid were spray dried by using different hydrocolloids including sodium alginate (Sigma-Aldrich, CAS Number, 9005-38-3, chemical Book), guar gum (Sigma-Aldrich, CAS Number, 9003-30-0), chitosan (Sigma-Aldrich, CAS Number, 9012-76-4, Tokyo chemical Industry Co. Ltd), and maltodextrin (Sigma-Aldrich, CAS Number 9050-36-6, SCBT-Santa Cruz Biotechnology) in two ratios 0.5 and 1% (w/v).The experimental groups were: 1) spray dried rumen fluid with 0.5% maltodextrin (RM0.5), 2) spray dried rumen fluid with 1% maltodextrin (RM1), 3) spray dried rumen fluid with 0.5% chitosan (RC0.5), 4) spray dried rumen fluid with 1% chitosan (RC1), 5) spray dried rumen fluid with 0.5% guar gum (RG0.5), 6) spray dried rumen fluid with 1% guar gum (RG1), 7) spray dried rumen fluid with 0.5% alginate (RA0.5), 8) spray dried rumen fluid with 1% alginate (RA1), 9) spray dried rumen fluid with no hydrocolloid (RN). A laboratory scale spray dryer (Armfield Mini Spray Dryer, England) with two-fluid nozzles (inner diameter: 0.5 mm) was used for spray drying. The system was operated in a co-current manner with an inlet and outlet air temperature of 120 ° C and 50 ° C, respectively. Feed rate change in 240e640 mL/h was necessary to achieve a constant outlet temperature. A spray flow rate of 500 mL/h was used and the aspiration rate was 70%. The powdered samples were stored in two layers polyester bags and kept in the refrigerator (5 ° C) until analysis.

2.2 Chemical analysis

The samples of dried ruminal fluid with spray drying method with various hydrocolloids analysed for dry matte, ash, ether extract and crud protein according to AOAC (16). The nitrogen-free extract was calculated by reducing samples % ash, % NDF, % Ether Extract, % crude protein, crude fat from 100 to the following formula.

NFE = 100 – (%ash + %NDF + % Ether Extract + % crude protein).

2.3 Determination of minerals

The minerals of samples were determined according to AOAC [16]. Sodium and potassium were determined by photometric method using FP 640, Jeumeay and phosphorous was measured through Vonado molybdate Yellow method using spectrometer Jenway 1315 UK (UV-visible). The amount of calcium and magnesium were determined using Atomic Absorption Spectrometer (Buck 210, AAS)

2.4 Data collection and statistical analysis

The chemical composition and mineral of the analyzed samples in laboratory were expressed in the mean. The results were expressed as percentages of mean and standard error of mean as described by Aliyu et al. [17].

Table 1. Approximate analysis of ruminal liquid dried with the spray drying method to various hydrocolloids

Item	Moistre (%)	CP (%)	EE (%)	Ash (%)	NDF (%)	NFE (%)
RM0.5	6.6±0.30	12.55±0.29	2.96±0.21	21.00±0.35	24.20±0.19	39.29±0.25
RM1	6.2±0.41	12.27±0.33	2.19±0.33	22.38±0.51	24.65±0.35	38.51±0.36
RC0.5	6.3±0.33	13.08±0.44	2.80±0.51	17.00±0.23	27.60±0.38	39.52±0.41
RC1	6.9±0.43	11.85±0.36	3.29±0.35	16.95±0.54	28.01±0.42	36.90±0.36
RG0.5	6.8±0.36	10.5±0.54	2.39±0.41	22.48±0.32	26.21±0.24	38.42±0.52
RG1	5.8±0.43	9.98±0.43	2.64±0.52	20.00±0.65	27.32±0.22	40.06±0.38
RA0.5	6.8±0.53	12.92±0.54	2.86±0.36	16.70±0.21	24.62±0.25	42.90±0.39
RA1	8.8±0.47	12.30±0.34	1.92±0.51	16.30±0.41	25.30±0.64	44.18±0.43
RN	6.2±0.32	10.6±0.34	2.85±0.41	20.15±0.45	25.23±0.35	44.17±0.56

Values presented in means and standard errore of means (Means ± SE)

Table 2. Mineral composition of ruminal liquid dried with the spray drying method with various hydrocolloids

Item	Sodium (%)	Potassium(%)	Calcium(%)	Magnesium(%)	Phosphorous (%)
RM0.5	3.02±0.03	0.75±0.03	0.65±0.02	0.96±0.06	1.5±0.06
RM1	2.95±0.02	0.61±0.05	0.58±0.06	0.98±0.09	1.65±0.07
RC0.5	2.52±0.04	0.57±0.04	0.53±0.08	0.95±0.08	1.35±0.08

RC1	2.65±0.02	0.68±0.02	0.56±0.06	0.85±0.05	1.22±0.09
RG0.5	2.20±0.6	0.46±0.03	0.45±0.08	0.76±0.06	1.36±0.05
RG1	2.10±0.05	0.48±0.06	0.57±0.09	0.89±0.07	1.65±0.09
RA0.5	4.30±0.06	0.54±0.05	0.33±0.06	0.91±0.08	1.87±0.05
RA1	4.65±0.02	0.65±0.03	0.36±0.09	0.85±0.05	1.85±0.08
RN	2.45±0.05	0.67±0.06	0.55±0.05	0.96±0.08	1.35±0.05

Values presented in means and standard errore of means (Means ± SE)

3. RESULTS AND DISCUSSION

The amount of moisture has a range of 5.8 ± 0.43 to 8.8 ± 0.47 and is the highest in RA1 and the lowest in RG1 (Table 1). The values for moisture are lower than 14.64 % and 17.48 % reported by Gebrehawariat et al. [8] and Agbabiaka, Madubuike and Amadi [18]. The variation in the moisture content of the samples in this study could be attributed to the processing method. Because in this method, rumen fluid samples are dried with spray drying method samples can be exposed to extreme temperatures for a few seconds [19], which can lead to a decrease in moisture. The spray drying method produces a stable and storeable product that can be stored for a long time [19].Among the tested hydrocolloids Guar gum was more successful in reducing the ruminal fluid moisture content. The crude protein content of this material ranged from 9.98 ± 0.43 to 13.08 ± 0.44 and the highest was RC0.5, and the lowest was RG1 (Table 1). These values were lower than the 18.58 percent reported by Agbabiaka, Anukam and Nwachukwu [20] and in the study of Gebrehawariat et al. [8]. was 11.80 and in Sakaba et al. [21] study, it was reported at 15.35 %.

Insoluble by spray drying technique may alter the 3D protein structure similar to denaturation [22]. The cutting forces that occur in the nozzle of the device also cause the protein to be denatured [23]. Protective effects of hydrocolloids have been reported in relation to the denaturation of heat [24] and the change in the 3D structure of the protein decreases in the presence of compounds such as polysaccharides, proteins or salts [22]. 1 % chitosan during the spray drying method maintained the percentage of rumen fluid protein. Also the variation in the amount of crude protein is related to the variety and quality of forage consumed by the animal and the soil from which the forage is grown. It can be due to the population and activity of microorganisms during the pre-killing period [25,26]. And the ruminal liquid dried with spray drying with this percentage of the protein recommended in the ration of the animal.

The amount of Ether Extract has a range of 1.29 ± 0.51 to 3.29 ± 0.35 and the highest was RC1, and the lowest was RA1 (Table 1). These values were higher than 1.22 percent and 1.69 percent reported by Gebrehawariat et al. [8] and Agbabiaka, Madubuike and Amadi [18]. The variation in lipid is also attributed to the variety, stage of maturity of the plants used in the ration animal, drying method and hydrocolloid used The amount of 16.30 ± 0.41% for RA1 and 22.48 ± 0.32% for RG0.5 for ash (Table 1) in this study was less than the 48.73 % reported by Sakaba et al. [9]. And the amount of ash in the study

by Gebrehawariat et al. [8]. was 21.47%. The NDF content has a range of 24.20±0.19 to 28.01±0.42. And its highest value in RC1 and its lowest value in RM0.5.(Table 1). These values were greater than 11.00 %, 18.44 % and 22.99 % reported by Sakaba et al. [9]. Sakaba et al. [21]. and Gebrehawariat et al. [8]. And of the 34.91 percent reported by Agbabiaka, Madubuike and Amadi [18]. In this study, the hydrocolloid itself has been used as a fiber and has been effective in increasing NDF content. Also, the variation in the amount of NDF depends on the stage of maturity and the degree of fibrillation of the forage used in the livestock. Agbabiaka, Madubuike and Amadi [18]. The amount of carbohydrates (36.90 ± 0.0.26 to 44.18 ± 0.56) in this study (Table 1) was more than 19.98 reported by Sakaba et al. [9]. And with amount 40.8 of and 38.13 reported by Dairo et al. [24], Agbabiaka Madubuike and Amadi [18]. almost equal. This is attributed to the sparing effect of carbohydrate. The chemical analysis of ruminal liquid dried with spray drying method and various hydrocolloids have shown that these materials are active after spray drying and can be used as an additive in the diet of animals

As shown in Table 2 the amount of sodium has a range of 2.10 ± 0.05 to 4.95 ±0. 02 percent in this study, with the highest value of RA1 being the lowest in RG1. That this amount of sodium was less than 19.98 percent reported by Sankaba et al. [9]. In the Sakaba et al. [9]. study was 2.46 percent. In this study, hydrocolloid sodium alginate has a sodium element and has been effective in increasing sodium content.The amount of potassium in this study ranged from 0.46 ± 0.03 to 0.76 ± 0.03. The amount of potassium in the Sakaba et al. [9]. study was 0.64 %. The amount of calcium had a range of 0.33 ± 0.09 to 0.65 ± 0.02 in this study. the amount of magnesium was 0.76 ± 0.06 to 0.96 ± 0.06 and the phosphorus content was 1.22 ± 0.09 to 1.87 ± 0.08 percent. This study showed that the ruminal fluid dried with spray drying method with different hydrocolloids had a small amount of minerals.

4. CONCLUSION AND RECOMMENDATIONS

This study showed that the spray drying method along with various hydrocolloids can be used to dry sensitive compositions such as rumen fluid and the ruminal fluid, in addition to microorganisms, vitamins containing microbial protein and enzymes. The spray drying method along with the hydrocolloids has been effective in maintaining these compounds. We can use this material as an additive in the ration of the animal. It is suggested that other encapsulation methods, such as freeze drying and other hydrocolloids, are also tested.

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