Full Length Articles

NUTRIENT PROFILE AND *IN VITRO* GAS PRODUCTION ANALYSIS OF SOME NEWER FEED RESOURCES FOR DAIRY CATTLE

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ABSTRACT

The present study was carried out to assess the nutrient composition and in vitro gas production analysis of some commonly available newer feed resources to use them as a conventional feed for dairy cattle. Eight different newer feed resources namely Pomegranate peel, Sugarcane bagasse, Orange peel, Mango seed kernel, Banana leaves, Carrot pulp waste, Neem oil cake and Poultry manure were collected and screened for their nutrient composition, in vitro gas production analysis and their gross energy values. The results showed that the crude protein and crude fiber content of newer feed resources ranged from 1.98 % to 20.88 % and 4.93 % to 25.36 % respectively. The ether extract and total ash content ranged from 0.48 % to 11.36 % and 1.77% to 19.11 % respectively. The levels of nitrogen free extract ranged from 41.4 % to 77.3 %. The Neutral Detergent Fibre and Acid Detergent Fibre content ranged from15.21 % to 78.15 % and 14.27 % to 57.78 % respectively. The total gas production of carrot pulp waste recorded the highest values (48.29 ml) and banana leaves recorded the lowest values (2.47 ml) among the newer feed resources. The highest and lowest gross energy value was recorded in neem oil cake (4926 kcal/kg) and poultry manure (3235 kcal/kg) respectively. It was concluded that the ingredients contained appreciable level of dietary nutrients make them to substitutes for the conventional feed sources for dairy cattle.

Key words: Newer feed resources, Nutrient composition, Gross energy value and *in vitro* gas production

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INTRODUCTION

Based on the livestock population in India, the deficit of dry fodder, green fodder and concentrates would be 21.3 %, 40.0 % and 38.1 % respectively by 2025,

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while the requirement would increase against the availability (Gorti *et al.*, 2012). The main reason for the poor animal production is the inadequate supply and low level of feeding due to serious shortage of feedstuffs (Onte *et al*., 2019). Further, a major constraint to increasing livestock productivity in developing countries - is the scarcity and fluctuating quantity and quality of the year-round supply of conventional feeds. In order to meet the projected high demand of livestock products and to fulfil the future hopes of feeding livestock, the better utilization of non-conventional feed resources which do not compete with human food is imperative (Maghsoud *et al*., 2008). Crop residues, agro-industrial by-products and browse foliage are increasingly becoming an important role as feed in future for livestock (Amata *et al*., 2014). The efficient utilization of by-products also has direct impact on the economy and decreasing the environmental pollution in the country. Non-utilization or under utilization of by-products not only lead to loss of potential revenues but also lead to the added and increasing cost of disposal of these products (Jayathilakan *et al*., 2012). Several factors may account for their limited use, among which is their low nutritive value, seasonal availability, high cost of handling and transportation from the production site to the farm, presence of anti-nutritional factors etc., (Onte *et al*., 2019). The major constraints in using these products as livestock feed are their high moisture content and presence of contaminants. Drying and ensiling have been used for enhancing shelf life and easier incorporation in animal feeds. Vegetable wastes and by-products are also good sources of micro- and macro-minerals (Bakshi *et al*., 2016). Mango seed kernel is having good amount of carbohydrates (58-80%), with moderate quantities of protein (6-10%) and fat (Admasu *et al*., 2020). Poultry manure offers a cost-effective option for meeting dairy cattle protein requirements, since it is cheaply available (not readily) at farm level (Lanyasunya *et al*., 2006). The different products of neem (*Azadirachta indica*) are utilized for variety of purposes in industry, health and animal agriculture in the Indian subcontinent. The cake from seeds after oil extraction is a good source of nutrients (CP: 35-38%; EE: 4.5-55%; CF: 12-15%; Ca: 0.75%; P: 0.45% on DM), and in particular, the one out of its kernel is proteinaceous and is relatively balanced in its amino acid and mineral profile (Gowda and Sastry, 2000). Whenever the demand of conventional feed ingredients may go high, we can shift to using the unconventional feed ingredients within the inclusion level to increase the profit of production (Thirumalaisamy *et al*., 2016). Hence the present study was carried out to evaluate the nutrient composition, total gas production and gross energy value of eight different newer feed resources for dairy cattle.

MATERIALS AND METHODS

Sample collection and preparation

Four samples of each newer feed resources namely Pomegranate peel, Sugarcane bagasse, Orange peel, Mango seed kernel, Banana leaves, Carrot pulp waste, Neem oil cake and Poultry manure were collected from Chennai and Thiruvallur districts. Samples were dried in hot air oven at a temperature of 55-65° C to constant weight and ground to pass through 1 mm sieve and stored in airtight container for further analysis.

Nutrient composition

The collected feed ingredients were screened for their nutrient composition (Moisture, Crude protein, Ether extract, Crude fiber, Total Ash and Nitrogen free extracts) according to the procedures of AOAC (2000). The fiber fractionation (Neutral Detergent Fiber and Acid Detergent Fiber) was determined as per the method of Van Soest and Robertson (1976). The gross energy content was measured using bomb calorimeter (Automatic microprocessor bomb calorimeter, Rico Scientific Industries).

***In vitro* gas production analysis**

The *in vitro* gas production technique was carried out using Hohenheim gas production technique as per the procedure of Menke and Steingass *et al*. (1988). The rumen liquor was collected from three cattle maintained under well grazing and the content were pooled in to a thermos cud transport container under constant flushing of CO_2 and this composite sample was brought to the laboratory. The rumen contents were strained using four layered muslin cloth to an Erlenmeyer flask under continuous flushing with CO_2 and it was maintained at the temperature of 39ºC. The rumen fluid was mixed with media solution prepared as described by Menke and Steingass *et al*. (1988).

Two hundred mg of sample was weighed and transferred in 100 ml calibrated syringes. To all the calibrated syringes, 30 ml of rumen liquor containing inoculum was anaerobically transferred and incubated in a shaking water bath at 39ºC for a period of 24 hours. At the end of the incubation period, the total gas production was measured by subtracting the final and initial reading shown on calibrated syringe after 24 hours of incubation in shaking water bath. The data obtained were grouped and subjected to statistical analysis by one-way ANOVA using SPSS – version 15.0 statistical package.

RESULTS AND DISCUSSION

The nutrient composition of newer feed resources viz. Dry Matter, Crude Protein (CP), Crude Fiber (CF), Nitrogen Free Extract (NFE), Ether Extract (EE), Total Ash, Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF) in different samples have been presented in Table 1.

The Dry Matter value varied between 14.23 % (Pomegranate peel) to 95.17 % (Neem oil cake). The crude protein content was significantly lower ($p<0.05$) in sugarcane bagasse (1.98 %) and significantly higher ($p<0.05$) crude protein content was present in Neem oil cake (20.88 %) among eight feed ingredients studied. The crude fiber content ranged from 4.93 % (Mango seed kernel) to 25.36 % (sugarcane bagasse). The ether extract content was significantly lower ($p<0.05$) in pomegranate peel (0.48 %) and significantly higher ($p<0.05$) in Banana leaves (11.36%) when compared to other non-conventional feed resources. Total ash content ranged from 1.77 % in sugarcane bagasse to 19.11 % in Poultry manure. The Neem oil cake had significantly lower ($p<0.05$) nitrogen free extract (41.4 %) and Mango seed kernel (77.31%) had significantly higher ($p<0.05$) nitrogen free extract when compared to other feed ingredients.

The nutrient composition of pomegranate peel determined in the present study was in conformity with the earlier findings of Mirzaei – Aghsaghali *et al*. (2011) and Popat *et al*. (2018). The highest CP content observed in Neem oil cake of the current study was consistent with earlier report by Reddy *et al.* (1988) who observed 20.9 % CP in the neem seed cake. The CP content of sugarcane bagasse was in conformity with the result of Mahrous *et al*. (2011) who reported the CP content of sugarcane bagasse with 2.40 %. The highest CF present in sugarcane bagasse was similar to the earlier finding (45.30 %) of Mahrous *et al*. (2011). The lowest CF observed in mango seed kernel in the present study coincided with the values (3.96% and 3.98 %) obtained by Changso (2008) and Admasu *et al*. (2020) respectively. The ether extract content for banana leaves in the present study was higher than that reported by Oliveira *et al*. (2007). Total ash content of poultry manure was in agreement with the research works (20.5%) reported by Lanyasunya *et al*. (2006). The NFE content of mango seed kernel was in consistent with the observation of Banerjee (1998) and NFE content of neem oil cake, was comparable with the earlier findings (46.20%) of Christopher (1970). It also became clear that the proximate composition of by-products can vary largely as a result of different processing methods and materials (Mirzaei-Aghsaghali *et al*., 2011).

The NDF and ADF content ranged from 15.21% (Carrot pulp Waste) to 78.15% (sugarcane bagasse) and 14.27% (Poultry Manure) to 57.78% (sugarcane bagasse) respectively. The NDF content of Carrot pulp waste in the present study was higher than the earlier finding of Wadhwa and Bakshi (2013). The ADF value observed for poultry manure was lower than the earlier report by Lanyasunya *et al*. (2006). The result of the current study was inconsistent with Mahrous *et al.* (2011) who found that the NDF and ADF values for sugarcane bagasse with 73.20 % and 61.50 % respectively.

The gross energy values and *in vitro* gas production of the newer feed resources are presented in Table 2. The gross energy values (kcal/kg) significantly differed with higher ($p<0.05$) in Neem oil cake (4926 ± 9.19) when compared among other feed ingredients. In contrast to the present study, Odunsi *et al*. (2009) reported that the untreated neem seed cake contained 3252 kcal/kg of gross energy which was considerably lower than the present study. Smith *et al*. (2001) observed the higher gross energy value (3560 kcal/kg) of the broiler chicks excreta when compared with the gross energy value of poultry manure (3234.5 kcal/kg) in the present study.

The changes in the nutrient composition and gross energy values in the present study compared with the earlier reports may be due to the variation in the plant species, soil and climatic condition.

In vitro total gas production values of eight different newer feed resources ranged from 2.47 ml to 48.29 ml. The total gas production value was significantly higher in carrot pulp waste (48.29 ml) and significantly lower in banana leaves (2.47 ml) when compared to other feed ingredients. Yeganehpour *et al*. (2021) reported that the carrot pulp waste produced 358.2 ml / g of feed in 24 hours incubation which was

Table 1. Nutrient composition of newer feed resources (% dry matter basis) (Mean# ± SE)

S. No.	Ingredients	Dry Matter	Crude protein	Ether Extract	Crude Fiber	Total Ash	Nitrogen Free Extract	NDF	ADF
1.	Pomegranate peel	$14.23^a \pm 0.14$	$3.38^b \pm 0.12$	$0.48^a \pm 0.02$	$14.41^d \pm 0.19$	$3.83^b \pm 0.03$	$77.18^g \pm 0.21$	$27.90^b \pm 0.02$	$17.29^b \pm 0.01$
2.	Sugarcane bagasse	$34.71^e \pm 0.12$	$1.98^a \pm 0.03$	$0.56^a \pm 0.048$	$25.36^h \pm 0.19$	$1.77^a \pm 0.04$	$70.31^d \pm 0.19$	$78.15^f \pm 0.03$	$57.78^g \pm 0.05$
3.	Orange peel	$21.15^c \pm 0.18$	$7.07^e \pm 0.03$	$1.53^c \pm 0.08$	$12.70^c \pm 0.08$	$4.55^c \pm 0.12$	$74.13^e \pm 0.21$	$39.48^e \pm 0.10$	$42.33^f \pm 0.10$
4.	Mango seed kernel	$41.49^f \pm 0.19$	$6.30^d \pm 0.06$	$7.82^e \pm 0.07$	$4.93^a \pm 0.004$	$3.62^b \pm 0.08$	$77.31^g \pm 0.12$	$30.67^c \pm 0.09$	$22.37^c \pm 0.10$
5.	Banana leaves	$23.75^d \pm 0.22$	$12.29^f \pm 0.19$	$11.36^g \pm 0.06$	$19.86^f \pm 0.14$	$10.31^e \pm 0.15$	$46.16^b \pm 0.37$	$67.37^g \pm 0.07$	$37.49^e \pm 0.15$
6.	Carrot pulp waste	$15.41^b \pm 0.10$	$5.13^c \pm 0.04$	$2.62^d \pm 0.01$	$11.76^b \pm 0.093$	$4.64^c \pm 0.12$	$75.83^f \pm 0.25$	$15.21^a \pm 0.11$	$18.58^b \pm 0.03$
7.	Neem oil cake	$95.17^h \pm 0.02$	$20.88^h \pm 0.266$	$10.32^f \pm 0.14$	$21.14^g \pm 0.17$	$6.25^d \pm 0.11$	$41.40^a \pm 0.45$	$34.37^d \pm 0.17$	$25.78^d \pm 0.39$
8.	Poultry manure	$81.57^g \pm 0.11$	$14.01^g \pm 0.10$	$0.87^b \pm 0.05$	$18.42^e \pm 0.36$	$19.11^f \pm 0.09$	$47.57^c \pm 0.31$	$39.27^e \pm 0.13$	$14.27^a \pm 0.09$
	P - value	0.026	0.007	0.013	0.001	0.076	0.738	0.077	0.004

#Mean of four observations

Means bearing different superscript in a column differ significantly with ($p<0.05$)

Table 2. Gross energy content (Kcal/Kg) and *in vitro* gas production (ml) of newer feed resources (Mean# ± SE)

S.No	Ingredients	Gross Energy (Kcal/Kg)	Total gas production (ml)
1.	Pomegranate peel	$3720^b \pm 4.24$	$11.16^c \pm 0.09$
2.	Sugarcane bagasse	$3862^c \pm 12.02$	$22.89^f \pm 0.12$
3.	Orange peel	$3903^c \pm 6.36$	$23.52^g \pm 0.25$
4.	Mango seed kernel	$4255^d \pm 4.24$	$15.44^e \pm 0.20$
5.	Banana leaves	$4347^e \pm 2.82$	$2.47^a \pm 0.16$
6.	Carrot pulp waste	$3732^b \pm 17.67$	$48.29^h \pm 0.26$
7.	Neem oil cake	$4926^f \pm 9.19$	$7.29^b \pm 0.17$
8.	Poultry manure	$3234.5^a \pm 4.59$	$13.42^d \pm 0.19$
	P - value	0.459	0.202

#Mean of four observations

Means bearing different superscript in a column differ significantly with ($p<0.05$)

higher than the present study. The higher gas production capacity of carrot pomace may be due to the presence of easy to digest molecules like soluble sugars and highly degradable fibers (pectin) in the structure of carrot pomace (Azizi *et al*., 2019) than the present study. According to the current result, the banana leaves produced 2 ml/200 mg DM during 24 hours incubation was also lower than the earlier report by 4.67 mL 200 mg^{-1} DM (Teixeira *et al*., 2021).

Agricultural and food industry residues, refusals and wastes constitute a significant proportion (estimated to amount to over 30%) of worldwide agricultural productivity. These wastes include lignocellulosic materials, fruit and vegetable wastes, sugar industry wastes as well as animal and fisheries operations refuse and wastes etc., used as alternate feed resource for livestock and poultry (Ugwuanyi *et al*., 2009). Also, a substantial amount of fruit wastes and by-products can be added into animal diets resulting in bringing back the food waste into human food chain with concomitant mitigation of environmental problems that emanate from the decomposition of such wastes in the environment (Bakshi *et al*., 2016). Further a concerted research and commercial efforts are needed to realize the full potential for the animal agriculture relationship for the utilization of agricultural by products.

Year round supply of sufficient feeds for livestock is the priority area for profitable livestock production (Hossain *et al*., 2015). Thus, non-conventional feeds could partly fill the gap in the feed supply, decrease competition for food between humans and animals, reduce feed cost, and contribute to self sufficiency in nutrients from locally available feed sources (Onte *et al*., 2019). However, precaution has to be taken to eliminate the potential anti-nutritional factors of some newer feed resources which might cause toxic effects to livestock.

It was concluded that the estimated newer feed resources in the present study could be effectively included in the ration for feeding of dairy cattle, will definitely reduce the production cost. The feeding trials of these alternate feed ingredients still need to be conducted to assess the effect of newer feed resources on animal performance with respect to digestibility, palatability and to establish the level of inclusion, economic and productive efficiency under practical farm conditions.

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