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Effect of heat moisture treated cassava (*Manihot utilissima*) on milk composition of early lactating crossbred cows

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Abstract
A 90-day study examined how the supplementation of heat-moisture treated (HMT) cassava (*Manihot utlissima*) to the diet of early lactating crossbred cows affect their milk composition. Twenty cows were randomly distributed into four groups: a control group (T_1) receiving a standard diet, and three groups (T_2, T3, and T_4) that received the standard diet plus 250g of cassava, each with different number of HMT cycles, daily. All cows received green fodder and paddy straw as roughage. The cows' body weights and daily dry matter intake were similar across all groups throughout the study. Milk component level showed no significant differences among treatment groups. The findings suggested that a 250g daily supplement of HMT cassava does not significantly alter milk composition of early lactating crossbred cows.

Keywords: Heat-moisture treatment, cassava, milk composition

1. Introduction
For maintaining the health and productivity of dairy cattle, especially high-yielding cows with increased energy demands, appropriate nutrition is very important. Intensive feeding strategies often involve diets rich in easily digestible carbohydrates to support milk production (Khiaosa-Ard and Zebeli, 2012) [9]. However, excessive consumption of rapidly fermentable starches can disturb the rumen environment, potentially causing sub-acute ruminal acidosis (SARA) or in more severe cases, acute ruminal acidosis (ARA), characterized by ruminal pH dropping below 5.8 and 5, respectively (Nagaraja and Titgemeyer, 2007) [11]. Several research works have been conducted to formulate a suitable feeding regimen to prevent the occurrence of SARA in cattle. When starch is broken down in the rumen, it generates hydrogen (H_2), which contribute to methane production and it also produces carbon dioxide (CO_2). In contrast, starch digestion in the small intestine leads to glucose formation, which can be absorbed directly. It is believed that the energy efficiency of utilizing glucose absorbed from the small intestine is higher than that of starch fermented in the rumen (Owens *et al.*, 1986) [12].
Heat-moisture treatment (HMT) followed by cooling could effectively enhance the resistant starch (RS) content in feeds that are high in starch (Dupuis *et al.*, 2014) [4]. As, cassava (*Manihot utilissima*) is one among the easily available starch sources in tropics, it was used as raw material for the study. In view of all these factors, HMT cassava was used here to investigate the effect of starch digested in the intestine on the milk composition of early lactating cross bred cows.

2. Materials and methods
2.1 Feed preparation
Locally sourced, dried cassava (*Manihot utilissima*) was ground into flour at School of Animal Nutrition Feed Technology (SANFT), Mannuthy. This flour was then processed using heat-moisture treatment (HMT), involving a cycle at 121°C with a steam of 3 bar pressure (w/v). Three cassava flour samples were created: HMT I, HMT II, and HMT III, corresponding to one, two, and three HMT cycles, respectively. Each sample was then rapidly cooled at -20°C for six hours (based on a method modified from Putra *et al.*, 2023) [13].

The levels of resistant starch in each of the HMT-treated cassava flour samples were measured (using a method modified from Sopade and Gidely, 2009) [16]. The samples exhibiting the highest resistant starch (HMT II and HMT III) content was then selected for further *in vivo* study.

2.2 Feed analysis
The proximate composition of feed and fodder, viz. Moisture, crude protein (CP), crude fibre (CF), ether extract (EE), total ash and nitrogen free extract (NFE) and fibre fractions were analysed (AOAC, 2016).

2.3 Experimental layout
Twenty early lactating crossbred cows from the cattle breeding farm, Thumburmuzhy were randomly assigned to four treatment groups (T_1, T_2, T3 and T_4), with five animals in each group. For 90 days, all cows received a diet of concentrate mixture (20% crude protein and 68% total digestible nutrients), green fodder and paddy straw, following ICAR (2013) [5] guidelines. In addition to this base diet, cows in groups T_2, T3, and T_4 were supplemented daily with 250g of HMT0, 250g of HMT II and 250g HMT III cassava, respectively. Table 1 details the specific ingredient composition of each of the four experimental rations. All animals were kept under the same management conditions within the farm.

Table 1: Ingredient composition of the experimental concentrate mixture* fed to experimental animals

Ingredient	Percentage composition			
	T_1	T_2	T_3	T4
Corn gluten fibre	25.0	25.0	25.0	25.0
Coconut cake	10.0	10.0	10.0	10.0
De-oiled rice bran	16.0	16.0	16.0	16.0
Black gram husk	8.0	8.0	8.0	8.0
Maize	16.0	16.0	16.0	16.0
Rice polish	8.0	8.0	8.0	8.0
Tapioca starch waste	1.0	1.0	1.0	1.0
Alfalfa	13.0	13.0	13.0	13.0
Calcite	1.5	1.5	1.5	1.5
Mineral mixture	0.5	0.5	0.5	0.5
Salt	1.0	1.0	1.0	1.0
Total	100	100	100	100
HMT 0 cassava		250.0 g		
HMT II cassava			250.0 g	
HMT III cassava				250.0 g

To every 100 kg of the concentrate feed, 100 g of Toxfia (containing specially treated hydrated sodium calcium aluminosilicates, mannan oligosaccharides, and choline chloride with buffered organic acid- propionic acid, acetic acid, benzoic acid, citric acid and liver protective ingredients) was added.

2.3 Milk analysis
Morning and evening milk samples were collected from individual animals every fortnight and pooled samples were analysed for total solids, protein (AOAC, 2016) [1] and fat (IS: 1224, 1977) [7]. From the above data, the solids not fat (SNF) was calculated.

2.4 Statistical anlaysis
Data obtained on the milk parameters during the course of the experiment were analysed statistically as per Snedecor and Cochran (1994) [15] by using the software statistical programme for social sciences (SPSS) version 24.0.

3. Results and discussion
3.1 Chemical composition of feed
The per cent composition of the concentrate mixture, green grass and paddy straw fed to the experimental animals in four experimental rations are given in Table 2 and chemical composition of the cassava samples supplemented are given in Table 3.

Table 2: Chemical composition[1] of the concentrate feed, green fodder and paddy straw fed to the experimental animals

Parameters	Concentrate	Green fodder	Paddy straw
Dry matter	90.54±0.26	17.52±0.14	90.83±0.33
Crude protein	20.91±0.24	10.55±0.15	2.98±0.02
Ether extract	4.37±0.10	2.04±0.03	1.14±0.02
Crude fibre	8.82±0.08	30.90±0.12	30.81±0.58
Total ash	10.55±0.12	10.10±0.09	14.48±0.10
Nitrogen free extract (NFE)	53.89±0.32	46.41±0.18	50.60±0.61
Calcium	0.86±0.01	0.55±0.01	0.28±0.00
Phosphorus	0.53±0.01	0.24±0.01	0.09±0.00
Neutral detergent fibre (NDF)	32.74±0.15	61.84±0.09	68.83±0.25
Acid detergent fibre (ADF)	14.51±0.11	40.89±0.10	47.22±0.22

[1]Mean of six values with SE

Table 3: Chemical composition[1] of the cassava samples fed to the experimental animals

Parameters	Cassava samples		
	HMT 0	HMT II	HMT III
Dry matter	94.04±0.09	88.80±0.22	87.85±0.10
Crude protein	2.39±0.02	2.73±0.01	2.91±0.01
Ether extract	0.96±0.02	1.35±0.03	1.73±0.06
Crude fibre	4.40±0.06	5.25±0.05	5.83±0.07
Total ash	1.68±0.02	1.72±0.03	1.73±0.03
Nitrogen free extract	90.57±0.21	88.94±0.23	87.8±0.32
Calcium	0.46±0.03	0.44±0.01	0.40±0.00
Phosphorus	0.36±0.02	0.32±0.03	0.31±0.01
Neutral detergent fibre	5.61±0.08	8.90±0.08	9.83±0.06
Acid detergent fibre	2.73±0.05	2.95±0.13	3.33±0.10

[1]Mean of six values with SE

3.2 Milk total solids
The average milk total solids content obtained in animals in four different treatment groups were 11.83±0.12, 11.72±0.07, 11.98±0.06 and 11.94±0.03 per cent respectively for T_1, T_2, T3 and T_4, as shown in table 3 and illustrated in fig. 1. The statistical analysis of the data showed similar (p>0.05) milk total solids yield among the treatment groups. Similarly, a comparable value of total solids in milk were obtained by Jayaraj (2021) [8] in animals of ULF and FRDS, Mannuthy.

Table 3: Fortnightly milk total solids content[1] of the experimental animals maintained on the four experimental rations, %

Fortnight	Dietary treatments				P-Value
	T_1	T_2	T_3	T_4	
1	11.87±0.28	11.76±0.20	12.03±0.18	12.18±0.22	0.585 ns
2	11.65±0.17	11.70±0.10	11.92±0.04	11.93±0.13	0.277 ns
3	11.91±0.11	11.74±0.17	11.95±0.03	11.88±0.08	0.573 ns
4	11.83±0.10	11.68±0.05	11.94±0.10	11.92±0.12	0.257 ns
5	11.92±0.08	11.73±0.09	11.96±0.06	11.77±0.12	0.242 ns
6	11.79±0.12	11.95±0.03	12.01±0.15	11.97±0.11	0.547 ns
Mean ± SE	11.83±0.12	11.72±0.07	11.98±0.06	11.94±0.03	0.108ns

[1]Mean of five values with SE; ns- non significant (p>0.05)

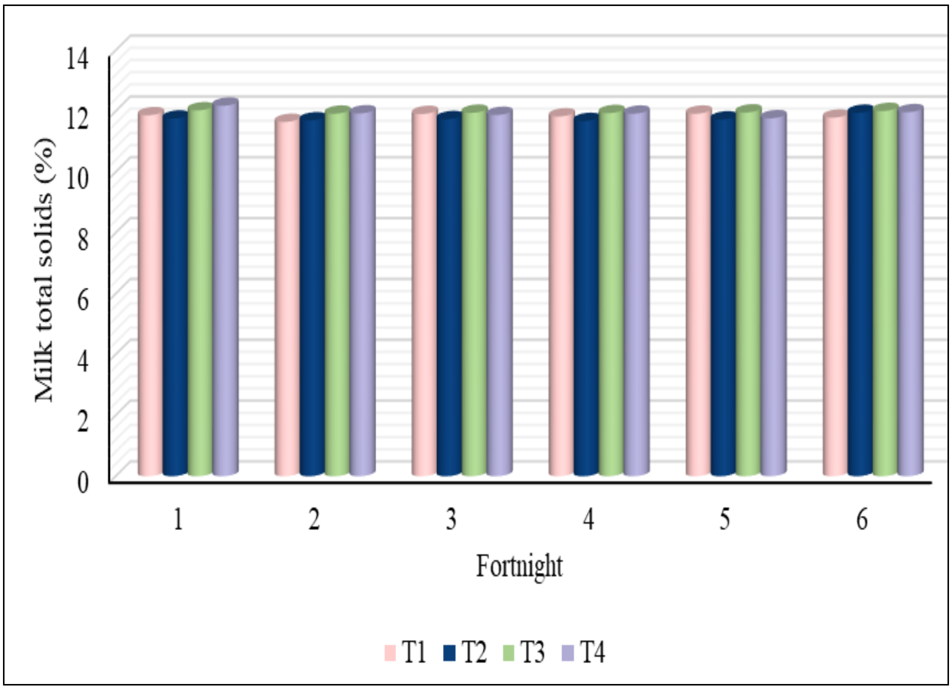

Fig 1: Fortnightly milk total solids content of the experimental animals maintained on the four experimental rations

3.3 Milk fat

The average milk fat per cent in milk from experimental lactating cows maintained in four experimental rations were 3.67±0.08, 3.59±0.08, 3.82±0.04 and 3.75±0.09 per cent for T_1, T_2, T3 and T_4 respectively, as depicted in table 4 and in fig. 2. The results demonstrated here is corresponding to that of Delahoy *et al.* (2003) [3] who reported that feeding lactating cows with cracked corn or steam flaked corn (SFC) do not bring any significant difference in milk fat production. Similarly, Boerman et al. (2015) [2] reported no significant difference in milk fat in cows fed with 30 per cent ground corn compared to those fed with 30 per cent soy hulls. Contrary to this, Whelan *et al.* (2012) [17] fed dairy cows in early lactation, a pasture-based diet supplemented with a higher level (5.17 kg of DM/d) of a barley- or maize-based supplement and observed an improvement in milk fat production in cows offered maize as a supplement.

Table 4: Fortnightly milk fat contenT_1 of the experimental animals maintained on the four experimental rations, %

Fortnight	Dietary treatments				P-Value
	T_1	T_2	T_3	T_4	
1	3.62±0.15	3.42±0.16	3.76±0.09	3.62±0.11	0.351 ^{ns}
2	3.50±0.13	3.44±0.09	3.80±0.06	3.74±0.11	0.056 ^{ns}
3	3.60±0.08	3.60±0.10	3.80±0.03	3.74±0.14	0.371 ^{ns}
4	3.70±0.10	3.78±0.06	3.76±0.06	3.78±0.12	0.914 ^{ns}
5	3.86±0.10	3.72±0.13	3.88±0.05	3.84±0.07	0.620 ^{ns}
6	3.74±0.07	3.60±0.09	3.92±0.07	3.80±0.09	0.086 ^{ns}
Mean ± SE	3.67±0.08	3.59±0.08	3.82±0.04	3.75±0.09	0.224 ^{ns}

[1]Mean of five values with SE; ns-non significant (p>0.05)

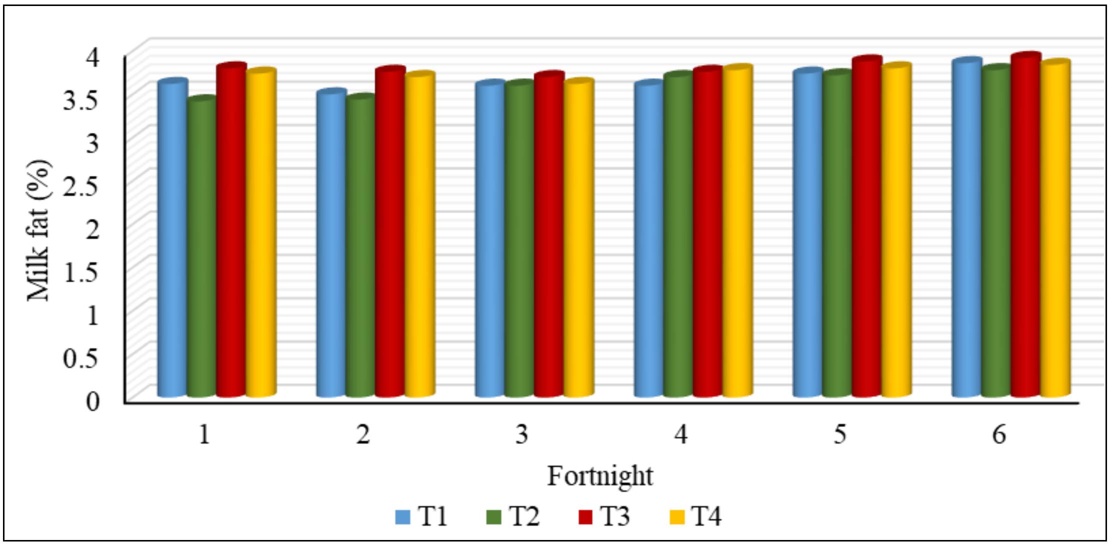

Fig 2: Fortnightly milk fat content of the experimental animals maintained on the four experimental rations

3.4 Milk protein

The mean value of milk protein yield from experimental dairy cows maintained on four treatment rations were 3.06±0.04, 3.05±0.02, 3.07±0.05 and 3.09±0.02 for T_1, T_2, T3, T_4 respectively. The data is shown in table 5 and illustrated in fig. 3. The statistical analysis of the data indicated that there were no significant differences (p>0.05) in milk protein yield among the treatment groups. Milk protein content in the treatment group fed with barley grains steeped in 0.5 per cent lactic acid for 48 hours were statistically similar to that of control group fed with barley grains steeped in an equal quantity of tap water (Iqbal *et al.*, 2009) [6]. Similarly, Delahoy *et al.* (2003) [3] reported similar milk protein production when cows were fed steam flaked or cracked corn. However, McKay *et al.* (2019) [10] found that animals receiving a barley-based concentrate in addition to pasture had a higher milk protein content compared to those that were fed a maize-based concentrate along with pasture.

Table 5: Fortnightly milk protein contenT1 of the experimental animals maintained on the four experimental rations, %

Fortnight	T_1 (Mean ± SE)	T_2 (Mean ± SE)	T_3 (Mean ± SE)	T_4 (Mean ± SE)	p-value
1	3.03±0.05	3.11±0.05	3.12±0.09	3.09±0.04	0.749^{ns}
2	3.00±0.04	3.04±0.03	3.10±0.07	3.06±0.03	0.504^{ns}
3	3.13±0.09	3.04±0.02	3.06±0.06	3.11±0.04	0.645^{ns}
4	3.06±0.04	3.06±0.02	3.04±0.02	3.13±0.04	0.303^{ns}
5	3.06±0.06	3.06±0.03	3.04±0.02	3.11±0.03	0.616^{ns}
6	3.07±0.03	3.01±0.02	3.08±0.06	3.08±0.02	0.520^{ns}
Mean ± SE	3.06±0.04	3.05±0.02	3.07±0.05	3.10±0.02	0.882^{ns}

[1]Mean of five values with SE, NS-non-significant (p>0.05)

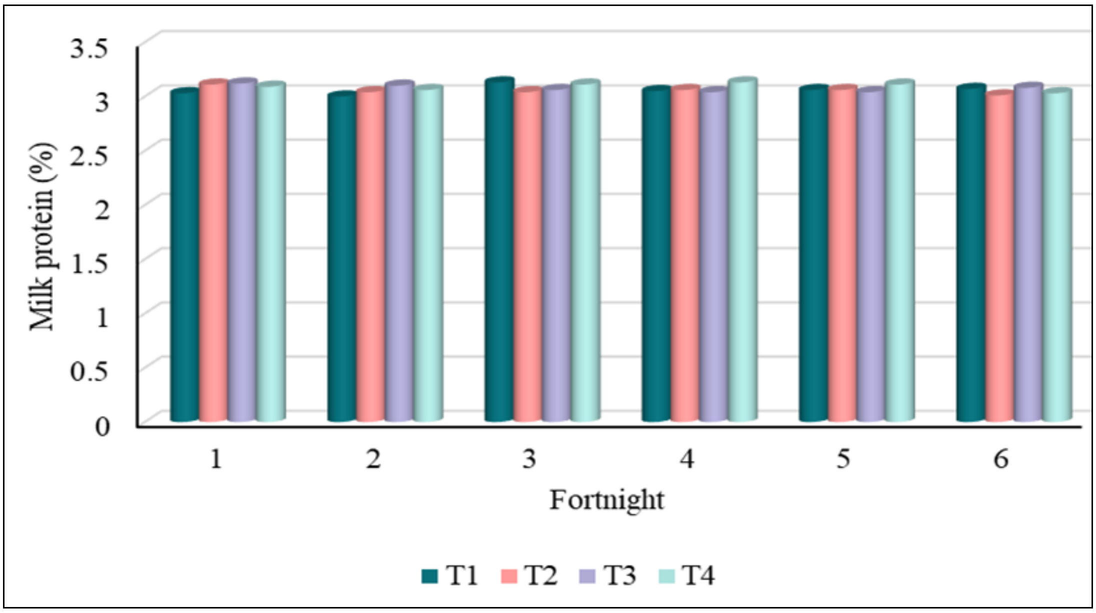

Fig 3: Fortnightly milk protein content of the experimental animals maintained on the four experimental rations

3.5 Solids not fat (SNF)

The data of SNF obtained is depicted in table 6 and fig. 4. The average SNF content in the milk of the experimental animals maintained on four experimental rations were 8.16±0.07, 8.12±0.03, 8.16±0.04 and 8.15±0.05 in T_1, T_2, T3,T_4, respectively and they were statistically similar across groups (p>0.05). In line with the findings of this study, Yu *et al.* (1998)[18] similarly found no differences in milk SNF production among groups of cows fed steam-flaked, steam-rolled, finely ground, or coarsely ground corn. But, Reis *et al.* (1997)[14] found that supplementation of ground maize to lactating cow which were given legumes as the only roughage showed an elevation in milk SNF content.

Table 6: Fortnightly milk solids not fat contenT1 of the experimental animals maintained on the four experimental rations, %

Fortnight	Dietary treatments				P-Value
	T_1	T_2	T_3	T_4	
1	8.25±0.17	8.34±0.06	8.27±0.14	8.34±0.20	0.962 ^{ns}
2	8.15±0.09	7.99±0.06	8.17±0.05	8.19±0.05	0.161 ^{ns}
3	8.31±0.08	8.14±0.09	8.15±0.06	8.14±0.12	0.469 ^{ns}
4	8.13±0.11	7.90±0.07	8.18±0.07	8.14±0.07	0.116 ^{ns}
5	8.06±0.08	8.01±0.09	8.08±0.04	7.93±0.15	0.711 ^{ns}
6	8.05±0.09	8.35±0.12	8.09±0.11	8.17±0.08	0.217 ^{ns}
Mean ± SE	8.16±0.07	8.12±0.03	8.16±0.04	8.15±0.05	0.948^{ns}

[1]Mean of five values with SE, NS-non-significant (p>0.05)

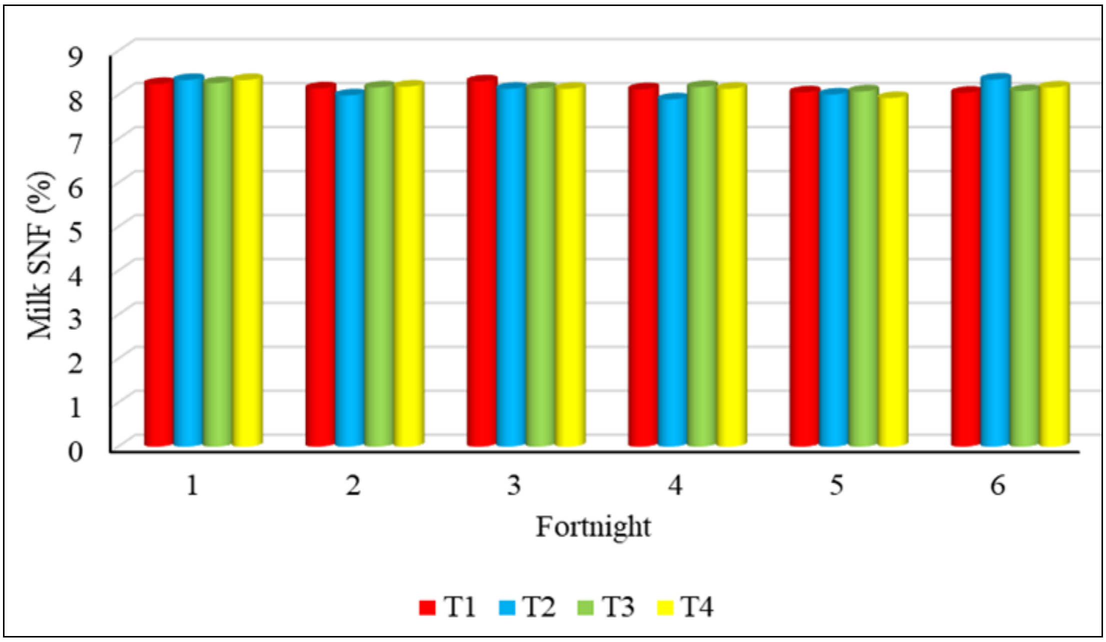

Fig 4: Fortnightly milk solids not fat content of the experimental animals maintained on the four experimental rations

4. Conclusion

The study revealed that supplementation of cassava with or without HMT at a level of 250 grams per day to early lactating crossbred cows did not have any significant effect on the composition of milk of the animals.

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Conflict of Interest

Not available

Financial Support

Not available

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