World Journal of Dairy & Food Sciences 15 (1): 32-38, 2020
ISSN 1817-308X

DOI: 10.5829/idosi.wjdfs.2020.32.38

Sensory Characteristics of Dairy Products from Horro Cows Fed Rhodes Grass Hay Basal Diets Supplemented with *Ficus sur* (Cv. Forssk) Fruits

[1]Diribe Kumsa, [2]Mitiku Eshetu and [1]Diriba Diba

[1]Department of Animal Sciences, Wollega University, Nekemte, Ethiopia
[2]School of Animal and Range Sciences, Haramaya University, Dire Dawa, Ethiopia

Abstract: An experiment was conducted at Guduru Animal Production and Research Center (GAPRC) of Wollega University, in Horro Guduru Wollega Zone, to evaluate the effect of *Ficus sur* (Cv. Forssk) fruits and oats grains supplementation on sensory attributes of dairy products from Horro cows fed Rhodes grass hay (RGH) basal diet. Twelve healthy lactating Horro cows of similar lactation stage, body weight and condition were selected from GAPRC. All of the selected cows were in early (one weak to 10 days) lactation stage. The experiment had three treatments with four replications managed in randomized complete block design to which 2-5 parities were used as blocking factor and three cows were used per parity. The treatments were: T1 (1.7kg Oat grain +0.8kg Noug seed cake); T2 (+0.56kg Noug seed cake+0.97kg oat grain +0.97kg *Ficus sur* fruits) and T3 (0.8kg Noug seed cake+ 1.7kg *Ficus sur* fruits). In all the three treatments, Rhodes grass was provided *ad libitum*. The experiment was conducted for 60 days, out of which 15 days were for adaptation and 45 days were for actual experiment. Twenty consumer panelists were used to evaluate the sensory attributes of dairy products from the cows. Higher proportion of FSF (T3) in the dietary mix improved the preference for the sensory attributes (flavor/taste, aroma/odor, color) of yogurt, cheese and butter. Except for butter, there was no significant difference (P>0.05) on preference for texture of yogurt and cheese. In conclusion, supplementation of Horro cows, fed Rhodes grass hay basal diet, with highest level of FSF has improved sensory acceptance of panelists for yogurt, cheese and butter.

Key words: Dairy Products · *Ficus sur* Fruits · Horro Cows · Sensory Characteristics

INTRODUCTION

Dairy production, among the livestock sector, plays an important role in Ethiopia serving as sources of food and income. Regardless of their number and importance; however, the productivity of dairy animals in Ethiopia is usually low and incompatible to the high population of existing cows. The national average milk yield per cow per day is 1.54 liters for indigenous cows and per capita/year milk consumption in the country is about 16 kg/year, which is much lower than African and world per capita average of 27 kg/year and 100 kg/year, respectively [1]. This low level of productivity of Ethiopian cows could be attributed largely to poor nutrition [2].

Animal feeds, among other factors, affect not only the yield but also the quality of dairy products [3]. Dairy products include milk and milk products such as yogurt, cheese and butter. Quality evaluation for dairy products may include mainly nutrient composition and sensory properties tests [4]. Among these tests, the simplest, most rapid and direct approach is sensory evaluation [5]. Sensory evaluation of food items started long ago as there have been human beings sensing the goodness or badness of food, water and everything else that they used to consume [6]. Sensory evaluation is incorporated in many food companies in different countries [7] as a means of determining quality of products.

Sensory sciences have evolved into a set of quantitative procedures that enhance the efficiency and accuracy of food product development, quality control, market research and marketing [8]. Sensory evaluation, alone or in combination with analytical procedures, is useful for quality control in the dairy industry.

Corresponding Author: Diribe Kumsa, Department of Animal Sciences, Wollega University, Nekemte, Ethiopia.

Predictability and quality of dairy products have improved in the past century as a direct result of formalized dairy product evaluation programs [8]. Human sensory evaluation will always be a most critical component for advancing the industry's assurance of higher quality dairy products for consumers. However, the effect of locally available *Ficus sur* fruits (FSF) on sensory property of dairy products such as yogurt, cheese and butter was not studied yet. The objective of this study, therefore, was to investigate the effect of *FSF* supplementation on sensory property of dairy products from Horro cows.

MATERIALS AND METHODS

The Study Area: The study was conducted in Horro-Guduru Wollega zone, at Horro Guduru Animal Production and Research Center of Wollega University. The Center is located at about 300 km west of Addis Ababa. The geographical coordinates of the study area is 09°29´N and 37°26´E. The altitude of the center is approximately 2296 m.a.s.l. The area has one rainy season extending from March to mid-October [9]. The monthly mean temperature varies between 14.9°C to 17.5°C and annual rainfall ranging from 1000 – 2400 mm. Mixed crop-livestock agriculture is the dominant production system in the area. Maize (*Zea mays*), teff (*Eragrostis teff*), wheat, sorghum (*Sorghum bicolor*), Niger seeds (*Gizotia abysinica*) and other cereals and pulses are the main crops growing in the study area while cattle, sheep, goats, equines, poultry and honey bee production are the major animal species produced in the area [10].

Experimental Animals and Management: Twelve healthy, lactating Horro cows of similar lactation stage and body condition were selected from Horro Guduru Animal Production and Research Center. All of the selected cows were from early lactation stage of one weak. Prior to the start of the experiment, all the cows were weighed and drenched with broad-spectrum anti-helminthics (Albendazole 500 mg). Continuous follow up on the health care of the animals was made throughout the experiment. The cows were maintained and stall-fed individually in a well-ventilated and concrete floor barn.

Experimental Feeds and Feeding Management: The late matured and naturally dried *Ficus sur* fruits (FSF*)* dropped from the tree were collected by casual workers. After collection, the fruits were further sun dried, finely crushed and stored in dry and clean room until it was used for the experiment.

Oat grain, regardless of variety, was purchased from the communities around the study area. These cereal grains were also crushed to similar aggregate size with crushed *Ficus sur* fruits. This was to avoid biasness in physical treatment of the diets. Noug seed cake was also purchased from nearby oil processing factories and crushed in similar manner as in the cases of the above energy supplements. Rhodes grass hay was used as a basal diet throughout the experimental period. The feed supplement was weighed and offered in a separate feed trough twice a day at 8:00 AM and 6:00 PM. The basal diet was fed *ad libitum* and adjusted up to 20% refusal level. Feed refusals were collected and weighed before the next feeding. Samples of feed offer and refusals were separately taken and bulked over 45 days for feed intake analysis. Feed intake was calculated as difference between the quantity of feed offered and feed refused. The animals had free access to clean water as required. The experiment was lasted for 60 days out of which 15 days were for adaptation and the rest 45 days were for actual experiment.

Treatments and Experimental Design

Treatments: The dietary treatments used in the feeding trial were managed as follows: Rhodes grass hay was offered *ad libitum* at 20% refusal rate plus Noug seed cake (NSC) supplement. The other two treatments received *ad libitum* Rhodes grass hay supplemented with different proportions of FSF and oats grain (OG) in addition to equal provision of NSC as given in Table 1. The gram amount of Noug seed cake (NSC), as protein supplement, varied based on the nitrogen content of energy diets, FSF and OG, to keep all the treatments at iso-nitrogenous level.

The average body weight of Horro cows used in the experiment was about 250 kg. Therefore, the amount of daily ration supplied was calculated as 2.5% of body weight which is 6.25kg. For a normal dairy cow, dry matter consumed within 24 hours should be 2.5-3% of its body weight. On the other hand, a cow weighing 600kg require 15.4kg dry matter when grazing for 8 hours [11]. The proportion of concentrate supplement to roughage was 40% of the 6.25kg which was 2.5kg per day and the rest was Rhodes grass hay. The treatment proportions for FSF and OG was calculated from the daily total concentrate level (2.5kg) in the ration.

Experimental Design: Three dietary treatments were randomly assigned to four cows which were arranged in Randomized Complete Block Design (RCBD) for the fixed effects. The lactating cows of similar lactation stage

Table 1: The Different Dietary proportions of FSF and OG used in the feeding experiment

No.	Diets	0% FSF:100% OG (T1)	50% FSF:50% OG (T2)	100% FSF: 0% OG (T3)
1.	NSC	0.80kg	0.56kg	0.80kg
2.	FSF	0.00	0.97kg	1.70kg
3.	OG	1.7kg	0.97kg	0.00
4.	RGH	*Ad libitum*	*Ad libitum*	*Ad libitum*

OG= Oat grain; FSF= *Ficus sur* fruit; NSC=Noug seed cake; RGH= Rhodes grass hay

(early stage of lactation) and similar body weight and condition were selected from the total lactating dairy herd. Two to five parity and three animals per parity were used as blocking factor. Numbers of animals used in this experiment (replication) were limited, because of shortage of budget to purchase feeds that can maintain cows for extended time than the present. Since the least error degree of freedom should be twelve, at least five animals per treatment should have been used under RCBD design and the duration of the experiment should also covered at least the whole early lactation period.

Since human sense is complex, being affected by many internal (physiology) and external factors (feeds and environments which affect sensory organs), we considered the random effects of factors on the panelists judgment (results) on sensory characteristics of the dairy products.

Chemical Analysis of Feeds: Chemical analysis of the feed samples was done at Holeta Agricultural Research Center. The samples were dried in an oven at 105°C overnight in a forced draft oven to determine the DM contents of the feed. The other part of feed samples dried at 65°C was ground to pass through 1mm screen size for chemical analysis. Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and Acid Detergent Lignin (ADL) were determined following the procedures of Van Soest and Robertson [12]. The ash and Nitrogen (N) content was analyzed according to the procedures described by AOAC [13]. Nitrogen was analyzed by Kjeldhal technique and CP was calculated as N x 6.25.

Sensory Attributes of Dairy Products: Five liters of fresh milk samples were collected from each of the three treatments and stored in smoked fermenting materials at room temperature for three days, in order to prepare traditional yogurt (or *Itittuu*). Clean cups were prepared for yogurt sensory testing. Another cup of water was provided to panelists for cleaning their mouth before tasting the yogurt and cheese produced from cows fed other treatment diets.

For preparation of butter, the partly reserved yogurt was churned to separate fat for sensory evaluation. The fat (butter) was separated and put in different labeled materials for sensory evaluation. The containers were smoked by the same smoking material (Olea Africana). *Itittu* is an Oromiffa word (local name) for concentrated and fermented milk. After churning butter was produced and was evaluated by panelists for acceptability of its appearance, color, texture, flavor and taste.

"Baaduu" is local name for a traditional Cottage cheese made from butter milk after the fat was removed by churning. Butter milk was put in clay pot and then scalded on charcoal fuel (about 45 to 50°C) until a discrete curd mass was developed and floated over the whey. Then it was separated from the whey, kept in clean plastic container and evaluated for sensory acceptability [5].

Sensory profiling of each dairy product (yogurt, butter and cheese) was conducted by panelists. Twenty consumer panelists were selected among the staff of Horro Guduru Animal Production and Research Center of Wollega University. The panelists were given a questionnaire with one to nine hedonic scales to test texture, color, flavor/taste, aroma of samples of dairy products as an effect of different treatments. Each attribute was scaled by using a 9-point structured hedonic scale (1 = extremely disliked to 9 = extremely liked").

Statistical Analysis: The data of the sensory attributes recorded during evaluation was statistically analyzed by using the Mixed Model procedure (fixed effects of feeds and random effects of panelists judgment) of statistical analysis system software [14] and means were separated by Duncan's Multiple Range Test (DMRT) at $\alpha = 0.05$.

The model used for the study was:

$$Y_{ij} = \mu + \tau i + \beta j + \varepsilon ij$$

where: i = 1...3; j = 1...4;
Y_{ij} = measured variables
μ = the overall mean
τ_i = the effect of i^{th} dietary treatment
β_j = the j^{th} random effects of assessors
ε_{ij} = random error

RESULTS AND DISCUSSION

Feed Chemical Composition: The result of the present study indicated that the dry matter (DM) content of OG and FSF were 90.68 and 93.90%, respectively (Table 2). The dry matter (DM) content of FSF (93.9%) is higher than the DM (87.3%) reported by Diriba [15] and that of OG (90.675) is lower than DM content of FSF. The CP content of FSF in this study was 7.4% which is comparable with the result (7.07%) reported by Diriba [15]. The current result indicates FSF fulfills the minimum CP (7%) requirement for microbial fermentation [16]. The NDF content of FSF was 32.7% which is in agreement with the report of Diriba [15] who found < 45% NDF for FSF.

In this study Oat grain (OG) has nearly similar DM (90.68%) value with 89 and 90.2% reported by Staton [17] and Mesfin *et al.* [18], respectively. The CP content (6.1%) of OG obtained in this study is lower than CP content (13% and 8%) reported by Staton [17] and Mesfin *et al.* [18], respectively. The CP content found in the present study was below the minimum requirement of (7%) for ruminant, which needs strategic supplementation. The NDF content of OG (42.8%) obtained in this study is higher than the result (31% and 38.2%) reported by Staton [17] and Mesfin *et al.* [18], respectively.

The crude protein (CP) and neutral detergent fiber (NDF) content of Rhodes grass hay (RGH) used in this study were 7.08 and 70.22%, respectively (Table 2). The CP content of RGH is lower than the CP content (7.49%) reported by Belay *et al.* [19]. According to Van Soest [16] the CP content of RGH fulfills the minimum level of CP (7%) required for microbial function. The NDF content (70.22%) of RGH attained in this study is within the range of NDF content (55%, 75% and 80.8 %,) reported by Belay *et al.* [19].

The crude protein (CP), neutral detergent fiber (NDF) and dry matter (DM) content of Noug seed cake (NSC) used in this study was 33.55%, 37% and 97.2%, respectively (Table 2). The CP content of NSC falls within the range of 28.9 to 35.5% CP reported by Fantie and Solomon [20], Wondwosen [21] and Mulat [22]. NDF content of NSC (37%) is also comparable with the result (38.5%, 38.7%, 39.66%) reported by Fantie and Solomon [20], Wondwosen [21] and Mulat [22], respectively. The DM content of NSC (97.2%) is higher than the findings reported by Fantie and Solomon [20], Wondwosen [21] and Mulat [22]. This difference may be attributed to the method of oil processing in the plant.

Sensory Attributes of Yogurt, Butter and Cheese as Affected by Supplementary Diets: Table 3 shows sensory characteristics of yogurt as influenced by different proportions of FSF and OG diets. The sensory attributes of yogurt was significantly differed between the different treatment diets on aroma ($P<0.01$), taste ($P<0.001$) and color ($P<0.01$) but no significant difference ($P>0.05$) had been observed on the texture. The most aromatic yogurt was produced at highest level of FSF inclusion in the dietary mixes. The diets themselves, FSF and OG, were different in aroma on their natural being that FSF had better and attractive scent than OG. There is the fact that feeds with sensible aroma might have direct influence on dairy products sensory attributes. In this regard, Pavel [3] indicated that volatile compounds from pasture could be transferred to milk and milk products. However, for FSF diets, it might not be the direct odor but could be substances in it that enhanced the aroma of yogurt obtained from cows fed these fruits and thereby increased its preference by panelists. Had it been the direct effect, the yogurt could have attained the aroma of the FSF itself.

Increased levels of FSF in the diets had significantly increased ($P<0.001$) the preference of panelists for taste of the product. Taste of yogurt, in the current study, followed similar preference trend of its aroma in that cows consumed higher proportion of FSF in the diets could produce the tastiest yogurt. This could lead to the suggestion that FSF might have higher sugar content that contributed to the production of tasty yogurt compared to that obtained from cows consumed higher OG diets which was more fibrous (Table 2).

Concerning the colors of yogurt, the panelists noticed that the one produced from cows consumed lowest levels of OG in the dietary mixes were highly preferred. The green and quality Rhodes hay, in this case, after degraded by the rumen microbes, must have contributed to the preferred color of the yogurt. Even though FSF may not have direct contribution on enhancement of cellulolytic rumen microbes [23], it needs further elaboration how the efficient utilization of Rhodes grass hay by the cows consumed higher level of FSF was taken place so that the grass could contribute to the preferred color.

The effect of different proportion of FSF and OG mixed diets was indicated in Table 4. The sensory attributes of butter had showed significant difference between the different treatments ($P<0.001$) on aroma, color and texture. Accordingly, increased levels of FSF in the diets of the cows consistently enhanced the preference of panelists for aroma, color and texture of the butter.

Table 2: Nutrient compositions of the experimental feeds

	Chemical composition (%)					
Sample feeds	DM	Ash	CP	NDF	ADF	ADL
OG	90.68	5.15	6.10	42.80	20.00	15.10
FSF	93.90	4.83	7.40	32.70	17.20	10.50
NSC	97.20	6.80	33.55	37.00	26.40	15.70
RGH	91.71	9.19	7.08	70.22	37.83	4.86
Refusal						
RGH T1	96.35	5.33	1.24	80.20	50.50	8.00
RGH T2	96.65	5.40	1.11	80.60	48.30	8.10
RGH T3	94.93	4.98	1.02	75.60	50.20	11.30

ADF = acid detergent fiber; ADL = acid detergent lignin; CP = crude protein; DM = dry matter; NDF = neutral detergent fiber; NSC=Noug seed cake; RGH=Rhodes grass hay; T1 = RGH *ad libtum* + 1.7kg OG + 0.8kg NSC; T2 = RGH *ad libtum* + 0.56kg NSC + 0.97kg FSF + 0.97kg OG; T3 = RGH *ad libtum* + 0.8kg NSC + 1.7kg FSF. FSF= *Ficus sur* fruits

Table 3: Sensory Score of Yogurt from Horro cows fed Rhodes grass hay supplemented with different proportion of FSF and OG mixed diets

Treatment Diets	Aroma	Flavor/taste	Color	Texture
0%FSF +100% OG	3.33^{b}	3.42^{c}	3.24^{b}	2.25
50%FSF+50% OG	6.21^{a}	4.77^{b}	6.03^{a}	2.34
100%FSF+0% OG	6.39^{a}	6.93^{a}	6.30^{a}	2.43
Overall Mean	5.31	5.04	5.19	2.34
SE	0.99	0.83	0.92	0.47
SL	**	***	**	NS

^{abc} Means within the same column with different superscripts are significantly different at *(P<0.05); **(P<0.01); ***(P<0.001); T1 = RGH *ad libtum* + 1.7kg OG + 0.8 NSC; T2 = RGH *ad libtum* + 0.56kg NSC + 0.97kg FSF + 0.97kg OG; T3 = RGH *ad libtum* + 0.8kg NSC + 1.7kg FSF; CV= Coefficient of variation of mean; SL= Significance level; SE= standard error of mean; NS= not significant.

Table 4: Sensory score of butter from Horro cows fed Rhodes grass hay supplemented with different proportion of FSF and OG

Treatment Diets	Aroma	Color	Texture
0% FSF +100% OG	2.70^{c}	3.69^{c}	3.69^{c}
50% FSF+50% OG	6.12^{b}	5.04^{b}	5.49^{b}
100% FSF+0% OG	7.47^{a}	5.94^{a}	5.58^{a}
Overall Mean	5.43	4.89	4.92
SE	0.68	0.75	0.72
SL	***	***	***

^{abc} Means within the same column with different superscripts are significantly different at *(P<0.05); **(P<0.01); ***(P<0.001); T1 = RGH *ad libtum* + 1.7kg OG + 0.8 NSC; T2 = RGH *ad libtum* + 0.56kg NSC + 0.97kg FSF + 0.97kg OG; T3 = RGH *ad libtum* + 0.8kg NSC + 1.7kg FSF; SL= Significance level; SE= standard error of mean

The sensory differences observed in the current study could be due to milk constituents coming as effects of animal feed constituents consumed by the cows such as carotenoids, terpenoids and/or to milk constituents that the cows produced which are different when food constituents vary such as plasmin content or fat composition of milk [24]. According to this fact, it may need further analysis of FSF for the content of the above chemical for explicit confirmation.

The sensory score for cheese from Horro cows fed Rhodes grass hay supplemented with different proportion of FSF and OG diets was shown in Table 5. The feeds significantly affected (P<0.001) the sensory characteristics of cheese except for texture. The most preferred aroma, taste and color of cheese were obtained from the cows fed diets with highest FSF inclusions.

More ruminal ammonia N was transferred into milk protein with high concentrate feed levels than with low. Increased concentrate proportion in the diet of dairy cows resulted in reduced ruminal ammonia concentration and enhanced ammonia utilization for milk protein synthesis [25]. This means that microbial protein production was high in cows fed more concentrate feeds and this might have contributed to the nature of cheese produced. This is because when most fat in the milk was carefully separated as butter, the highest part of the nitrogen in the milk goes to cheese during processing [26]. Even though the feeds provided in the current study was provided for all cows at iso-nitrogenous level, the variation might be due to the roles of concentrate diets as explained by Agle *et al.* [25], where FSF was contains more soluble components than OG.

Table 5: Sensory score for cheese from Horro cows fed Rhodes grass hay supplemented with different proportion of FSF and OG

Treatment Diets	Aroma	Flavor/taste	Color	Texture
0% FSF +100% OG	3.96[b]	3.42[b]	3.51[b]	2.34
50% FSF+50% OG	5.85[a]	4.77[a]	5.13[a]	2.34
100% FSF+0% OG	6.57[a]	5.4[a]	5.85[a]	2.43
Over all Mean	5.46	4.53	4.83	2.37
SE	0.97	0.84	0.93	0.48
SL	***	***	***	NS

[abc] Means within the same column with different superscripts are significantly different at *(P<0.05); **(P<0.01); ***(P<0.001); T_1 = RGH *ad libtum* + 1.7kg OG + 0.8 NSC; T_2 = RGH *ad libtum* + 0.56kg NSC + 0.97kg FSF + 0.97kg OG; T_3 = RGH *ad libtum* + 0.8kg NSC + 1.7kg FSF; SL= Significance level; SE= standard error of mean; NS= not significant

CONCLUSIONS

From this experiment, it was observed that higher proportion of FSF in the dietary mix improved the sensory attributes such as flavor/taste, aroma and color of yogurt, cheese and butter. Except for butter, texture preference was not varied for the rest dairy products. Hence supplementation of Horro cows, fed Rhodes grass hay basal diet, with highest level of FSF has improved sensory acceptance of panelists for yogurt, cheese and butter.

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