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Exploring the food industry potential of novel goat milk bar produced by supplementing with rose flower extracts

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Abstract

Goat milk is a highly nutritious and an ideal wholesome food. Today, an increase in demand by consumers is witnessed towards consuming goat milk, mainly owed to their rich nutraceutical value. In this study, novel goat milk bar was developed by incorporating rose flower extracts as an added ingredient (concentration level: 0, 5, 10, 15 and 20%), and by using two different types of natural sweeteners (cane sugar and palm sugar). The nutrition bars were evaluated for proximate composition, texture properties and sensory qualities. Results obtained were encouraging and the new goat milk based nutritional bar formulation with added rose extracts certainly paves way for future commercial exploitation of the product. Goat milk, owing to its rich nutraceutical value, and rose extracts owing to the dual functions of a natural antioxidant and antimicrobial agent, can be beneficial for extending the shelf life of this novel product under room or refrigerated temperatures, thus attracting better markets.

Introduction

Today, an increase in demand by consumers is being witnessed towards consuming goat milk, mainly owed to their rich nutraceutical value (Suguna *et al*., 2012, 2014). Besides, the past two decades has witnessed an increase in goat milk production compared to other mammalian farm animals (FAO, 2001). The goat milk production is dominated in Bangladesh, India, and Pakistan, and goat milk contributes considerably for the total milk production in the regions of sub-Saharan Africa (13%) and parts of Southeast Asia (FAO, *http://www.fao.org/agriculture/dairy-gateway/milk-production/dairy-animals/small-ruminants/en/#.VDYy_U0cSM8*, assessed on 9th October 2014). Nutritionally, goat milk can be comparable to the cow milk with regard to content of milk sugar as well as protein. Goat milk contains short-chain fatty acids (such as caproic and caprylic acid) as well as smaller fat globules that renders them easier to digest (Fiona, 2003; Elwood *et al.*, 2007). Nutritionally versatile milk bars can be developed into an excellent instant food especially for children, young lactating women as well as can accomplish the daily minimal requirements of proteins and other essential nutrients in humans.

On the other hand, rose flowers (petals) are known to possess both food and therapeutic values. Rose flower petals have been traditionally utilized in various cultures as a natural food flavouring agent, for preparing herbal tea decoction, to cure common headaches as well as to aid in digestion and to soothe stomach discomforts. In addition, rose flower is reported to posses' rich antioxidant and antimicrobial activities (Özkan *et al.*, 2004). Presence of antimicrobial and antioxidant activities can be explored as a natural food preservative. Hence, developing novel products by using goat milk with added natural flavouring ingredient and a preservative (in the form of rose extract) can gain high commercial value. Based on this, the key intention to undertake the present study was: (i) to develop novel goat milk based nutrition bars to benefit the health conscious consumers and (ii) evaluate this new products acceptability by consumers so that it can be explored for commercial purposes.

Materials and Methods

Materials

Fresh, raw goat milk (~5L) was purchased from a local vendor engaged in commercial rearing of farm goats (Bukit Gambir, Penang, Malaysia). After the milking process, fresh milk was collected in sterilized plastic bags and were placed in an icebox (0°C) and transferred to the laboratory (Food Technology Division, Universiti Sains Malaysia) for further analysis (within 30 min.). Other ingredients

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used in the study such as cane sugar, palm sugar, rose were all purchased from a local supermarket.

Milk pasteurization process and rose extracts preparation

The fresh goat milk was heated to a pasteurization temperature of 63°C for 30 min. followed by cooling to room temperature. Then, the milk was stored in the refrigerator at 4°C until further use. Freshly purchased rose flowers (red colour) was washed with running tap water and drained to remove all the adherent dust particles. To prepare the rose extracts (at different concentrations of 5, 10, 15 and 20%), they were boiled in fresh potable water for a time of 10-15 minutes until all the extraction was complete (until the petals became colourless). We used rose petals extraction rather than directly using the petals. This is because extraction process of a plant product is universally accepted to enhance the flavouring/ aromatic compounds as well as bioactive compounds. Further, a 5-20% gradient concentration of rose flower extracts was used as our preliminary experiment. It was our hypothesis that if good results could be obtained then the concentration levels can be further enhanced based on the needs of the industries or for future commercial exploitation.

Preparation of milk bar

Goat milk based nutrition bar was developed by employing the traditional mode of preparation by taking into account and modifying the methods reported earlier on milk based preparation of dairy based products (Sarkar *et al*., 2002; Chetana *et al*., 2009). Briefly, pasteurized goat milk (300 mL) was mixed with a suitable sweetener (cane sugar and palm sugar/ gula Melaka, 90 g; taken individually) and rose extract (5, 10, 15 and 20% w/w), and was heated with constant stirring until the required total soluble solid (TSS) level of 83 ^{o}Brix (measured using a hand refractometer) was attained. We tried to develop two types of milk bars: first, by using cane sugar and the second was by using palm sugar as sweetener. Once boiled until the end was reached, the hot mass was then transferred to a sterilized stainless steel plate, spread uniformly and cooled to room temperature. The spread mass was further cut into small pieces of equal size (squares) to be considered as the nutrition bar. A suitable control samples was maintained for each of milk bar, which was based on the sweetener added.

Proximate composition, texture and sensory quality evaluation

Nutritional quality evaluation of the goat milk bar based on proximate composition (crude protein, fat, fiber, ash and moisture content) was determined by employing standard method of AOAC (2000). Texture analysis of the samples was performed by using a texture analyzer (TA-XT2) (Stable Microsystem, Surrey, UK).The force required (N) for a circular probe to penetrate into the milk bar was measured and reported.

For sensory analysis, trained panelists (students and staff) were recruited from the Food Technology Division, Universiti Sains Malaysia. Panelists were trained and instructed on various procedures to be followed while performing quality evaluation. Panelists were accommodated individually in the sensory testing laboratory, which had a controlled lighting, good airflow, and devoid of any distracting odours. Panelists were instructed to slowly chew 'at least' half of the provided sample and evaluate them for the acceptability based on the texture, aroma, colour, caramel flavour, taste and overall acceptability by using a 9-point hedonic scale (1 = dislike extremely, 5 = neither like, nor dislike, and 9 = like extremely) (Peryam and Pilgrim, 1957; David, 1998). Each protein bar sample was randomly coded with a 3-digit number before giving to panelists.

Statistical analysis

All the analysis in this study were performed in triplicates (n=3), and results generated were descriptively analyzed by using SPSS software, version 16.0 and MS excel. The mean values and standard deviation were calculated and analyzed to determine the level of significance (a = 0.05) by analysis of variance (ANOVA) along with Duncan's multiple range test.

Results and Discussion

In this study, as we used two types of sugar as sweeteners to produce goat milk based nutrition bar, the sweetness, texture and the mouth feel differed. Concentrated palm sugar is a natural product made from sap of either coconut tree (*Cocos nucifera* L.) or palmyra palm tree (*Borassus flabellifer* Linn.) (Tiapaiboon, 2004; Phaichamnan *et al*., 2010), while cane sugar is a product obtained after processing of sugarcane. Palm sugar (gula Melaka) owes a unique flavor and is traditionally used in selected confectionery and baking products. In addition to this, emphasis laid to utilize natural plant based products as an added food ingredient has resulted in exploring concentrated palm sugar as an alternative sweetener (Panyakul, 1995).

Table 1. Proximate composition of goat milk bar supplemented with rose flower extracts

Sample	Content (in %)				
	Protein	Fat	Fiber	Ash	Moisture
Control (with cane sugar)	5.87 ± 1.4^{abc}	2.55 ± 0.13^{ab}	0.009 ± 0.00^{a}	1.64 ± 0.01^{ab}	6.29
Cane sugar + 5% rose extract	3.12 ± 0.8^{a}	7.37 ± 1.01^{g}	0.006 ± 0.00^{a}	1.67 ± 0.03^{b}	6.56
Cane sugar + 10% rose extract	8.81 ± 0.7^{bcd}	3.17 ± 0.74^{b}	0.007 ± 0.00^{a}	1.57 ± 0.01^{a}	7.24
Cane sugar + 15% rose extract	10.55 ± 2.5^{d}	5.91 ± 0.07^{e}	0.008 ± 0.00^{a}	1.68 ± 0.01^{b}	6.98
Cane sugar + 20% rose extract	8.72 ± 3.6^{bcd}	6.78± 0.48^{fg}	0.010 ± 0.00^{a}	1.69 ± 0.04^{b}	7.68
Control (with palm sugar)	5.44 ± 2.4^{ab}	2.32 ± 0.07^{a}	0.012 ± 0.00^{a}	1.68 ± 0.06^{b}	6.15
Palm sugar + 5% rose extract	9.39 ± 2.4^{d}	3.91 ± 0.16^{c}	0.006 ± 0.00^{a}	1.84 ± 0.03^{c}	6.34
Palm sugar + 10% rose extract	9.76 ± 1.01^{d}	5.06 ± 0.15^{d}	0.010 ± 0.00^{a}	1.88 ± 0.03^{c}	7.34
Palm sugar + 15% rose extract	10.99 ± 1.04^{d}	6.48 ± 0.06^{ef}	0.011 ± 0.00^{a}	1.84 ± 0.07^{c}	6.08
Palm sugar + 20% rose extract	9.17 ± 1.03^{cd}	6.65 ± 0.08^{efg}	0.010 ± 0.00^{a}	1.85 ±a 0.06^{c}	8.57

Mean (n=3) ± standard deviation. Different letters in the same column denotes significant difference ($p<0.05$)

Composition

Our preliminary studies indicated protein content of raw and pasteurized goat milk to be 4.98 ± 0.1 and 4.95 ± 0.1, respectively, while that of fat to be 3.33 ± 0.3 and 3.68 ± 0.9 (%), respectively. Results obtained for proximate composition of the goat milk based nutrition bar is presented in Table 1. The moisture level, which can be a deciding factor of the overall stability and shelf-life of a new food product, showed varied results. Goat milk based nutrition bar prepared by using palm sugar + 20% of rose extract contained high moisture content (8.57%) compared to all the other samples under study. This is an indication that milk bar with palm sugar + 20% rose extract might tend to have a lower shelf-life compared to other samples. Protein and fat are the other two major essential ingredients in milk. If the level of these two essential components could be retained in the final milk based food products, then this can be prove to be highly beneficial. In this study, the nutrition bar prepared by using palm sugar + 15% of rose extract exhibited highest protein content (10.99%) followed by cane sugar + 15% rose extract (10.55%). The lowest protein content was recorded in milk bars with cane sugar + 5% rose extract (3.12%). Further, milk bar prepared by using cane sugar + 5 % rose extract had highest fat content (7.37%). With regard to fiber, control milk bar with palm sugar exhibited highest value (0.012%). As presence of rich amount of dietary fiber can help in preventing constipation and other diverticular diseases (diverticular bleeding, diverticulitis, diverticulosis), our results indicate that addition of external plant based natural fiber ingredient might be necessary to enhance the nutritional quality of the goat milk based protein bars. With regard to ash content, which is a direct representative of the minerals in a food-stuff, milk bar prepared by using palm sugar + 10% rose extract exhibited highest value (1.88%), whereas bars with cane sugar + 10% rose extract had lowest ash content (1.57%). Further, it is a well reported fact that rose petals have a varied range of proximate composition (Jilani *et al*., 2012; Youssef and Mousa, 2012). This can have a direct influence and contribute to the observed changes in the composition in the milk bar.

Texture and sensory quality evaluation

Texture is an important quality parameter that can promote consumer's acceptance for a new dairy-based food product. Besides, texture can impose a positive effect on rheological properties and can influence the shelf life of milk based food products (Karadbhajne and Bhoyarkar, 2010). The results obtained for textural analysis is shown in Table 2. Overall, the milk bar prepared using cane sugar had higher hardness

Table 2. Texture analysis of goat milk bar supplemented with rose flower extracts

Sample	Hardness (g)	Stickiness (g)	Springiness (g)
Control cane sugar	774.398 ± 23.6 [e]	-45.131 ± 2.76 [b]	45.653 ± 2.16 [a]
Cane sugar + 5% rose	811.546 ± 21.69 [f]	-48.312 ±5.00 [b]	53.111 ± 4.81 [b]
Cane sugar + 10% rose	789.354 ± 20.90 [c]	-41.716 ± 7.11[b]	46.890 ± 3.76 [a]
Cane sugar +15% rose	819.514 ± 25.98 [f]	-49.113 ± 9.56 [c]	55.631 ± 5.61 [b]
Cane sugar + 20% rose	850.975 ± 17.57 [f]	-43.615 ± 9.56 [b]	51.471 ± 0.96[b]
Control palm sugar	200.371 ± 10.54 [c]	-45.465 ± 7.56 [b]	57.678 ± 1.67 [c]
Palm sugar + 5% rose	150.000 ± 15.46[b]	-50.545 ± 6.54 [c]	55.675 ± 2.67 [b]
Palm sugar + 10% rose	314.213 ± 21.85[d]	-58.609 ± 7.53 [d]	57.927 ± 0.14 [c]
Palm sugar + 15% rose	131.563 ± 20.96 [b]	-27.004 ± 7.57[a]	54.557 ± 1.47 [b]
Palm sugar + 20% rose	69.532 ± 25.66 [a]	-57.413 ± 6.43 [d]	55.303 ± 2.56 [b]

Mean (n=3) ± standard deviation. Different letters in the same column denote significant difference ($p<0.05$)

compared to that of palm sugar. The hardness feature can be attributed mainly to the crystallization process occurring in the product. Earlier, Arora *et al*. (2007) have reported higher hardness in sucrose-sweetened milk compared to those prepared using low calorie sweeteners such as that of aspartame, saccharin, etc. With regard to stickiness, a negative value was recorded in all the samples. Stickiness is often a problem in food manufacturing process. This can be of particular concern especially when large volume of dairy-based preparations (productions) are involved, as it can enhance cost of the production as well as lead to a substantial loss in the food products quality (Hogan and O'Callaghan, 2013). For example: there are instances wherein incorporation of emulsifier in ice-milk increased the springiness compared to ice-milk without emulsifiers. In addition, soy protein based curd is reported to enhance the springiness as well as alter the primary structure of the basic protein network when compared to unheated soy protein curd, which did not have the network structure (Shukri *et al.*, 2014). In this study, the springiness varied among all the samples analyzed corresponding to the incorporated amount of rose extracts. Besides, it needs to be understood that during a food product formulation, texturants are capable of interacting with some of the major components such as protein, fat, carbohydrates and moisture and work synergistically to develop structure within a products matrix which enables the product to remain stable during storage (*http://www.foodbusinessnews.net/articles/news_home/Dairy_News/2014/07/Managing_the_mouthfeel_of_dair.aspx?ID=%7BF99B36B1-FA7B-41D6-B0FD-1908F2AD9551%7D*; assess date December 2, 2015).

Further, the results obtained for sensory quality evaluation is depicted in Table 3. Sensory quality results from descriptive analysis and consumer's acceptance tests are routinely employed to evaluate the impact of added food ingredients and processing variables when a new food product is developed. Providing results generated for sensory analysis can be of use to manufacturers to enhance the marketability of a new food product. In the present study, we employed a 9 point hedonic scale, which is the most popular and relevant one to the product we developed (Piggot, 1988; Stone *et al*., 2012). Results for the sensory based texture attributes revealed higher score given for palm sugar + 20% rose extract sample as well as for cane sugar + 10% rose extract (6.24), whereas palm sugar + 5% rose extract scored the least (4.96). Texture is considered to be a tactile feel property, which is a measure of the mechanical, geometrical, and moisture levels stimulated by the

Table 3. Sensory quality attributes of goat milk bar supplemented with rose flower extracts

Sample	Texture	Aroma	Caramel	Color	Taste	Overall Acceptability
Control (Cane sugar)	5.12 ± 1.76^{ab}	5.72 ± 1.62^{a}	5.48 ± 1.56^{a}	6.52 ± 1.68^{c}	5.76 ±1.61^{a}	5.84 ± 1.46^{a}
Cane sugar + 5% rose extract	5.40 ± 1.87^{ab}	6.20 ± 1.41^{a}	5.76 ± 1.58^{ab}	6.16 ± 1.17^{bc}	5.72 ± 1.67^{a}	6.16 ± 1.51^{a}
Cane sugar + 10% rose extract	6.24 ± 1.83^{b}	6.00 ± 1.50^{a}	5.64 ± 1.75^{ab}	4.76 ± 1.42^{a}	6.16 ± 1.65^{a}	6.08 ± 1.60^{a}
Cane sugar + 15% rose extract	5.76 ± 1.3^{ab}	7.04 ± 0.79^{b}	6.08 ± 1.15^{abc}	6.16 ± 1.12^{bc}	6.24 ± 1.42^{a}	6.56 ± 1.19^{a}
Cane sugar + 20% rose extract	5.28 ± 1.81^{ab}	6.52 ± 1.15^{ab}	6.12 ± 1.69^{abc}	5.84 ± 1.12^{bc}	6.40 ± 1.756^{a}	6.40 ± 1.32^{a}
Control (Palm sugar)	5.44 ± 1.08^{ab}	5.88 ± 1.20^{a}	6.08 ± 1.28^{abc}	6.16 ± 1.17^{bc}	6.04 ± 1.172^{a}	6.08 ± 0.86^{a}
Palm sugar + 5 % rose extract	4.96 ± 2.09^{a}	5.72 ± 1.42^{a}	6.56 ± 1.82^{bc}	6.12 ± 1.64^{bc}	6.40 ± 1.70^{a}	6.20 ± 1.60^{a}
Palm sugar + 10% rose extract	5.64 ± 1.68^{ab}	5.88 ± 1.33^{a}	6.64 ± 1.49^{bc}	6.08 ± 1.70^{bc}	6.52 ± 1.61^{a}	6.36 ± 1.57^{a}
Palm sugar +15% rose extract	5.52 ± 1.81^{ab}	6.20 ± 1.44^{a}	6.28 ± 1.33^{abc}	5.56 ± 1.12^{ab}	6.36 ± 1.46^{a}	6.24 ± 1.30^{a}
Palm sugar +20% rose extract	6.24 ± 1.83^{b}	6.48 ± 1.38^{ab}	6.92 ± 1.70^{c}	6.36 ± 1.86^{bc}	6.56 ± 1.78^{a}	6.52 ± 1.55^{a}

Mean (n = 25)± standard deviation. Different letters in the same column denotes significant difference ($p<0.05$) between mean obtained through Duncan's test.
Control = protein bar with only type of sugar and without rose extract;5 %, 10%, 15% and 20% rose refers to the concentration of rose extract added

nerves present on the surface of the lips, tongue and fingers (Piggott, 1988). For aroma attributes, cane sugar + 15% rose extract was given high score (7.04) whereas the control samples with cane sugar and palm sugar + 5% rose extract were given low scores (5.72) by the panelists. Aroma or the odour of a food can be a vital deciding phenomenon when a new product is developed, and this is a direct reflecting of the tasting attributes (from a sensory perception). In addition, aroma generation can involve a wide array of volatiles transiting through the nasal passage on inhalation by the sensory panellists (Meilgaard *et al.*, 1999; Trisnawati *et al.,* 2013). For the caramel attribute, palm sugar + 20% rose extract (6.92) was given highest score whereas control samples with cane sugar (5.48) was given least scoring. Overall, significant differences in the caramel flavour were recorded among various samples analyzed in this study. The difference in caramel flavour might be attributed to the use of two different types of sugars used in this study. Compared to cane sugar, palm sugar offer a unique rich taste to the goat milk based nutrition bar.

Concerning colour attributes, panelists gave high score for control milk bar with cane sugar (6.52); whereas cane sugar + 10% rose extract (4.76) gained low score. Overall, significant difference in the colour attributes were recorded, which might be accredited to variation in the type as well as concentration of sugars added. Visually, goat milk bars added with palm sugar was brown in colour, while those added with cane sugar was white, with a tinge of rose colour (red to pink). Overall, based on colour attributes the panelists gave a good scoring for nutrition bar prepared using cane sugar compared to those with palm sugar. For taste attributes, the palm sugar + 20% rose extract (6.56) gained highest score whereas cane sugar + 5% rose extract (5.72) gained low scoring by the panelists. Overall, based on the taste, palm sugar based nutrition bars were preferred by the panelists.

Finally, with regard to overall acceptability, the milk bars prepared with cane sugar + 15% roses extract sample (6.56) and palm sugar + 20% rose extract (6.52) were given high score, with the least score given to control milk bar samples prepared using cane sugar (5.84). Overall acceptance of a new food product can be identified as a multifaceted illustration of 'liking' of the product as a whole. In

addition, results on the overall acceptability from a consumer (panelists) point of view is important as it encompasses all the visible sensory qualities including those of colour, texture, size and shape. This can be of immense help for marketing and popularizing the new product.

Conclusion

Goat milk, owing to its rich nutraceutical value, can be a good source to produce nutrition bars. Addition of rose extract and different types of sugars as flavor enhancers can be advantageous from the marketing point of view. Moreover, addition of palm sugar in the preparation of goat milk based nutrition bars can be advantageous as it is not only a natural sweetener, but also has low glycemic index compared to refined sugar. In addition, rose extract can also acts as natural preservatives apart from the goat milk itself, which posses natural antimicrobial properties. Further studies are warranted to evaluate the shelf life of this novel product under room and refrigerated temperatures, which can be beneficial for attracting better markets.

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