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Utilization of Spent Tea Waste for the Development of New Milk Chocolate Product

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Abstract

Utilization of waste has become the prime importance and a great challenge in food processing. Black tea is normally high in consumption in Pakistan and the tea waste is generally discarded or used as fertilizer. Dried spent tea waste can be used as a replacer to cocoa powder for the production of various chocolate products. In the current study milk chocolate samples were prepared using five various compositions i.e. 1, 3, 5, 7 and 9g/100g of spent tea waste replacing cocoa powder along-with constant amount of other ingredients. Among the various combinations, the newly developed milk chocolate sample containing tea waste in a ratio of 5g/100g was found to be better for its functional properties and sensory evaluation. The water activity, pH, hardness, moisture, ash, protein, fat, fiber, carbohydrate, and energy content of newly developed samples were found to be 0.50Aw, 6.54, 4.54N, 6.9%, 0.743%, 7.35%, 20.8%, 2.60%, 26.4% and 510kcal/100g. The newly developed milk chocolate was wrapped in metallic coated polythene wrapper, packed in 50-micron polythene bags and stored at ambient (25 ± 2°C) as well as refrigerated (5 ± 2°C) condition for 6 months. The storage studies of new product indicated that the TSS, reducing and total sugars increased with the advancement of storage period, while moisture and acidity content decreased. The rate of both reactions during storage was observed relatively higher at ambient temperature than refrigerated temperature. Formation of bloom on the sample during storage at ambient temperature 25 ± 2°C and refrigerated temperature 5 ± 2°C, was also determined using standard method. By the end of 6 weeks no bloom formation was observed but after 8-week bloom formation was started to be detected. The similar composition of tea waste and cocoa powder make it possible to be used instead of cocoa powder. It is therefore, concluded that tea waste is a better substitute of a cocoa powder with an affordable initial cost and it can be used in a preparation of various chocolate products.

Keywords: Waste utilization, black tea, substitute, alkaloids, cocoa powder

Introduction

Waste utilization is the most preferable and most effective way to keeps the environment clean as not much waste will be accumulated in the surroundings. The presence of natural bioactive and antioxidants compounds in spent food waste have captured the interest of most of the scientist and food manufacturers (Mirabella, Castellani *et al.* 2014, Baiano 2014). Tea is the most extensively consumed beverage in the world after drinking water. Tea is reported to have anticancer, anti-inflamatory, antibiotic, antioxidant, cardiovascular prevention effects. These health effects have increased the demand of tea globally resulting in drastic increase of tea production. Utilization of enormous amount of tea results in a huge amount of spent tea waste. Therefore, utilizing such waste into sustainable nutraceutical food products is an intelligent way (Debnath, Haldar *et al.* 2021). Tea waste is not only a loss of biomass but also one of the cause of environmental stress. Tea waste has already been reported to use in energy generation, environmental radiation and in the preparation of electrical devices (Guo, Awasthi *et al.* 2021).

Recycling technology for spent tea waste to produce new food products development have reported to be established. An accumulation of this waste

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poses a problem to the environment, as it is prone to microbial spoilage, and therefore, there is a need to upgrade the recycling system in order to evaluate the potential for recycling the by-products from these wastes, to find out the possibilities of their use in different food formulations or the manufacture of health-promoting products or functional foods (Abdeltaif, SirElkhatim *et al.* 2018).

Cocoa powder is essentially used as flavor in biscuits, ice cream, dairy drinks and cakes. Apart its use as flavor it is also used in the manufacture of coatings for confectioners or frozen desserts. It is also consumed by the beverage industry for example for the preparation of chocolate milk (Beg, Ahmad *et al.* 2017). Formulation of chocolate from cocoa powder is quiet beneficial as it is very nutritious, powerful source of antioxidants, may improve blood flow and lower blood pressure, raises HDL and protects LDL from oxidation, may reduce heart disease risk, may protect your skin from the sun, and could improve brain function. As well the components of tea waste are similar to coco powder that not just create the great taste but also a good change in chocolate (Ju and Maskarinec 2016).

In order to utilize waste and keeping in view the compositional similarities of cocoa powder and spent tea waste, the objective of this study was to utilize the spent black tea waste to replace cocoa powder in producing milk chocolate. The sample produced in the current study will have higher chemical antioxidant activity than most of the chocolates available in the market.

Material & Method

Glassware

Analytical grade chemicals were used for analysis. All glassware was pre-rinsed with 10% HCl followed by deionized water.

Raw Material

The ingredients of milk chocolate including cane sugar (locally available), milk powder (Millac Milk Powder), cocoa powder (Hershey's Cocoa Powder), butter (Food Links International) and salt (Shan Foods Pvt. Ltd), were purchased from super market.

Tea waste spent domestically by the author was washed with distilled water and stored carefully in a clean and dry glass container. The spent tea waste was then kept for sun drying. After sun drying it was ground into powder (0.5mm) and was kept in sterile plastic bags before taken for further processing.

Preparation of Milk chocolate

Milk chocolate samples were prepared using five various compositions i.e. 1, 3, 5, 7 and 9g/100g of spent tea waste replacing cocoa powder and constant amount of other ingredients such as cane sugar, milk powder, hydrogenated fat and salt, whereas the control sample contains 20g/100g cocoa powder. The extract was mixed with other ingredients into stainless steel container. The mixture was then heated and was spread on 1.5 to 2.5 cm stainless steel cubes molds (smeared with fat). The heated mass was cooled for three hours to solidify.

Organoleptic Evaluation

Standard 9-point hedonic scale procedure was used to carry out the sensory (organoleptic) evaluation of the finally produced chocolates (Amerine, Pangborn *et al.* 1965). The mean score of each quality parameter such as overall acceptability, color, texture, flavor and taste were recorded which was analyzed by 20 trained/and semi trained panelist.

Packaging Material and Storage

The metallic coated polythene wrapper was used to wrap the final product, 50-micron polyethylene bags were used to pack and were kept for 6 months at 25 ± 2^{o}Cand at refrigerated temperature5 ± 2^{o}C.

Physico-Chemical Analysis

Physical tests of the final product such as moisture, water activity, pH, ash, colour and chemical analysis such as sucrose, reducing sugar and fat contents, titrable acidity, peroxide value, crude protein, crude fiber and carbohydrates were carried out according to the standard methods of AOAC (Chemists and Horwitz 1975). The hardness was analyzed by texture analyzer, and the calorific value was estimated by Bomb Calorimeter.

Microbial Analysis

Standard Plate Count (SPC) method was used to record microbial counts. Petri dishes with Potato Dextrose Agar (PDA) as the cultivation medium were kept for incubation at $37 \pm 5°$ C for 2 days. The colonies were counted by colony counter.

Bloom Formation

Formation of bloom on the sample during storage at ambient temperature $25 \pm 2°$C and refrigerated temperature $5 \pm 2°$C, was determined by the method available in literature (Samsudin and Ali A Rahim 1996).

Results& Discussion

Standardization of Chocolate Recipe

Table 1: Standardization of Milk Chocolate Recipe

Parameters	Control	Sample1	Sample2	Sample3	Sample4	Sample5
Spent tea wast	**0**	**1**	**3**	**5**	**7**	**9**
Organoleptic acceptability score*	8.50	8.0	8.25	8.75	7.15	6.65
Remarks	Control	Not Selected	Not Selected	**Selected**	Not Selected	Not Selected

* Nine-point hedonic scale:

The sensory analysts recommended the sample with 5g/100g tea waste with an acceptability score above average (Table-1). As compared to the control sample, both had almost the same taste, texture and mouth feel. The goal was to have the phenolic tea waste powder be undetectable in the flavor of the milk chocolate. The taste-testers found that concentrations over 5g/100g were discriminately detectable, but incorporating the tea waste at or less then 5g/100g sample resulted in a good compromise of a high level flavor.

The sensory score of fresh milk chocolate has been summarized in Table 2. The color of final product was observed to be 8.7 for control and sample prepared with spent tea waste. This might be due to bronze colour formation by tea waste. The scores for texture for control and sample3 were found to be 8.5 to 8.8, flavour scores were 8.4 to 8.8 and the taste scores were 8.4 and 8.7 respectively.

Both of the milk chocolate samples, control and sample prepared with tea waste, were found to be acceptable. The composition and better sensory scores of both of the products might have made both of the product acceptable.

Table 2: Sensory score of fresh Milk Chocolate

Parameters	Control	Sample with Tea Waste
Colour	8.7±0.02	8.7±0.01
Texture	8.5±0.04	8.8±0.03
Flavour	8.4±0.01	8.8±0.02
Taste	8.4±0.03	8.7±0.03
Organoleptic acceptability score*	8.50±0.03	8.75±0.03

Colour Analyis

The colour of controlled milk chocolate was light bronze, the addition of tea waste to the milk chocolate causes the colour to one tone darker (Table-3). Colour is one of the important qualities that attract consumers visually (Hutching 2003). The colour of milk chocolate is also influenced by the flavonoid content of spent tea waste replacing cocoa butter. It has been reported in literature that solution containing flavonoid will appear darker (Priecina and Karlina 2013).

Table 3: Colour Indices of Newly Developed Milk Chocolate

Colour Measurement	Control	Sample with Tea Waste
Lightness (L*)	41.8 ± 0.9	44.9 ± 0.7
Redness (a*)	8.5 ± 0.2	9.4 ± 0.7
Yellowness (b*)	6.1 ± 0.5	5.6 ± 0.9

Physical Analysis

The physical analysis of fresh milk chocolate (control and the sample containing tea waste) have been recorded in Table 4. Water activity was detected as 0.53 and 0.50Aw for control and sample prepared with tea waste respectively. The basic reason for migration of moisture in both of the products is the difference in water activity. Rapid migration of moisture is due to increase in water activity in both of the products. The wrapper protects the milk chocolate from moist air absorption. The results of pH analysis have provided an evident result that since the pH is neutral; it is suitable according to the product.

Hardness is one of the variables that are used to determine the texture profile of the food. The newly developed milk chocolate in this study is made from milk and fat. The hardness in newton is found 4.3N and 4.5N for control and sample prepared with tea waste respectively. The texture of milk chocolate is happened to be affected by the lesser moisture content, the interaction between milk protein and fat-soluble flavonoids. Moisture and fat content governs the texture i.e. runny, soft, chewy etc.

Table 4: Physical Analysis of the Milk Chocolate

Parameters	Controlled sample	Sample with Tea Waste
Water Activity (A_w)	0.53	0.50
pH	6.53	6.54
Hardness (N)	4.3	4.5
Calories (kcal/100g)	534	510

The calorific values for 100g sample were detected as 534 and 510kcal/100g for control and newly developed milk chocolate. The calorific values for serving size of usual chocolate (5g) indicate that the milk chocolate contains only 11.5% of the calories a person needs in a day. Therefore, it can be easily utilized with the confidence of not gaining weight.

Chemical Analysis

The results of chemical analysis of the fresh final product are summarized in Table 5. Food quality can be maintained by maintaining less moisture content in the food commodities; that will reduce the deterioration of food by decreasing microbial growth. In the current study the moisture content is found to be lesser which ascertains the quality of good product. The ash content in the controlled sample (0.743%) is found to be less than the ash content in the newly developed milk chocolate (0.787%). It is mainly because tea waste is a plant source which could be the reason of higher value in the later product. The ash content in both of the samples are found to be in acceptable limits, which make the product acceptable. The fat content is found to be within the range of 20.1± 0.94% and 20.8± 0.85% in both controlled and newly developed milk chocolate. It is reported to be in the limit which is imparting texture and also playing a part in the mouth feel of the newly developed product (Tavares and Noreña 2019).

The titerable acidity (TA) were found to be 0.20% in the control sample and 0.18% in the final product (Table 5). The milk protein positively affects the value of titerable acidity. Peroxide value is found to be less than the detection limit. This indicates that the product will stay stable for a longer time, and will not get rancid or lose its characteristics. Plate count value was found to be less than the detection limit. Confections are generally resistant to bacterial growth, but pathogens (if present) survival in the product for a long time is possible (Lund, Baird-Parker *et al.* 2000).

Table 5: Chemical Analysis of the Fresh Milk Chocolate

Parameters	Controlled sample	Sample with Tea Waste
Moisture Content(%)	7.5±0.04	6.9±0.05
Ash(%)	0.787±0.03	0.743±0.02
Carbohydrates%	28±0.25	26.4±0.62
Fat Content%	20.1± 0.94	20.8± 0.85
Titrable Acidity%	0.20± 0.05	0.18± 0.02
Peroxide Value	< the Detection Limit	< the Detection Limit
Crude Protein%	7.23 ± 0.05	7.35 ± 0.03
Crude Fiber%	2.1 ± 0.01	2.60 ± 0.01
Total Solids %	13.7±1.52	14.2±0.67
	Microbial Analysis	
Standard Plate Count	< the Detection Limit	< the Detection Limit

Shelf Life Determination

Free Fatty Acid (FFA) was another parameter used to determine the rate of decline in the quality of milk toffees. FFA shows the amount of free fatty acids in a product. Fig-1 shows that the FFA value of milk chocolate increases with the length of storage time at all two storage temperatures. The increase in FFA percentage is due to oxidation of the product. The oxidation reaction of milk chocolate is caused by the contact of oxygen with fat present in milk chocolate.

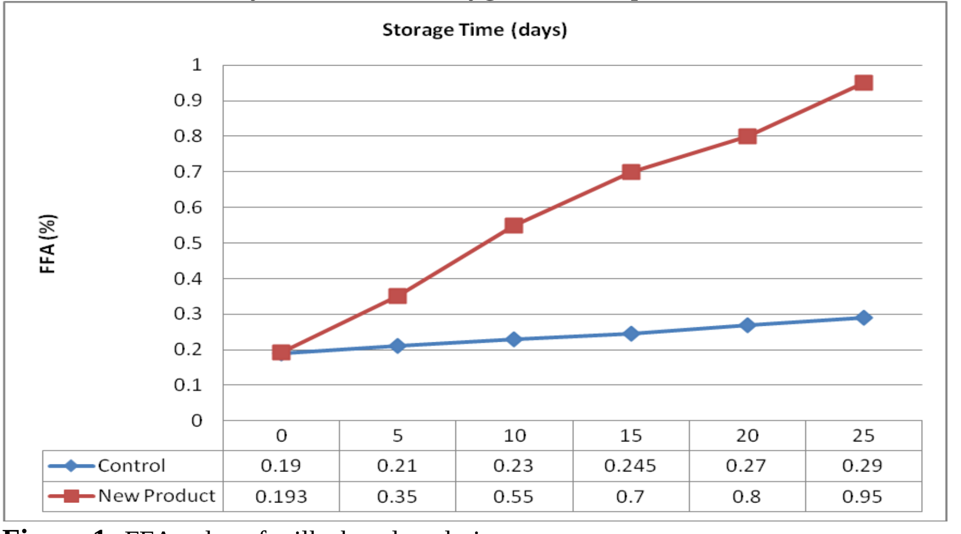


Figure 1: FFA value of milk chocolate during storage

Changes in Physico-Chemical Properties

The newly prepared milk chocolate samples were wrapped in metallic coated polythene wrapper, packed in 50-micron polythene bags and stored at ambient (25 ± 2°C) as well as refrigerated (5 ± 2°C) condition for 6 months. The chemical constituents of newly developed milk chocolate after 6 months were analyzed and recorded as Fig 2. The moisture loss of newly developed milk chocolate was recorded between 6.9 to 6.6 % and from 6.9 to 6.8 % at ambient temperature and refrigerated condition respectively. The temperature difference might be a reason of such decrease in moisture content. The values of TSS of newly developed milk chocolate were observed to be increased from 82.7 to 85.7°Brix at ambient temperature and from 82.7 to 85.1°Brix at refrigerated storage conditions, respectively. The decreased moisture content might be the reason of the increase in TSS in 6-month period. Maximum decrease in acidity value was observed from 0.17 to 0.15 % at ambient conditions and for refrigerated conditions from 0.17 to 0.16 %. Increase in the reducing sugars content was observed from at ambient temperature, and from 36.4 to 37.3% at refrigerated condition after 6-month. Spontaneous hydrolysis of non-reducing sugars might be the main reason behind the increase in reducing sugar contents. A similar pattern was observed for control sample.

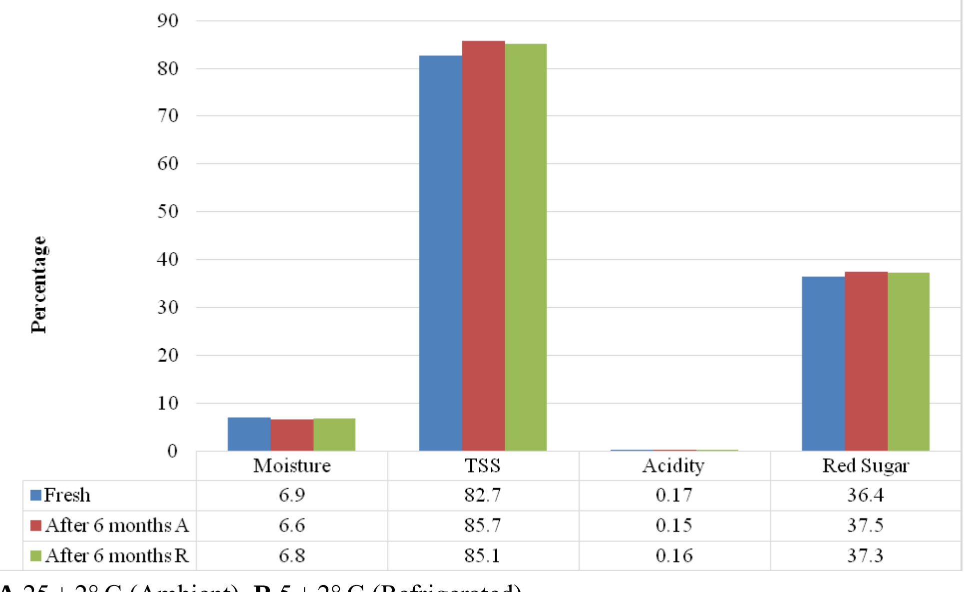
Bloom Formation

The effect of storage temperature at 25 ± 2° C (Ambient), and 5 ± 2° C (Refrigerated) on the bloom formation of the chocolate surface has been recorded in Table-6. By the end of 6 weeks no bloom formation was observed but after 8-week bloom formation was started to be detected. Recrystallization of cocoa butter and milk fat is the major reason of bloom formation (Ramli, Said *et al.* 2005). The migration of fat into the chocolate surface was observed to be increased with the passage of time and was found to be higher at high temperature.

Table 6: Fat Blooms Formation on Milk Chocolate during Storage

week	Ambient Temperature (25 ± 2° C)		Refrigerated Temperature (5 ± 2° C)	
	Control sample	Sample with Tea Waste	Control sample	Sample with Tea Waste
2	1	1	1	1
4	1	1	1	1
6	1	2	1	1
8	2	2	1	2
10	2	3	1	2
12	2	3	1	2

1- excellent (glossy, no bloom); 2- good (slightly dull, no bloom); 3- fair (surface dull, no bloom); 4- just acceptable (trace a bloom); 5- unacceptable (complete bloom)



A 25 ± 2° C (Ambient), **R** 5 ± 2° C (Refrigerated)

Figure 2: Changes in Chemical Properties of Final Product after 6 month

The acceptability of the product by the panel members after 6-month storage confirms that the minimum changes which might have occurred due to microbes were within the safe limit for human consumption.

The constituents of the product produced in the current study are natural, no artificial color and flavor is added to prepare the milk chocolate. The cost of product was calculated as per existing prices at the time of the study. It also has the market competent price therefore the product is likely to gain the attraction of consumer and improves the market trends.

Conclusion

In the present study a new product i.e. milk chocolate was produced aiming to use spent tea waste. Among the various combination, the tea waste mixed chocolate containing 5g/100g was found better than other combinations in respect to organoleptic properties and nutritional quality. The newly developed milk chocolate were wrapped in metallic coated polythene wrapper, packed in 50-micron polythene bags and stored at ambient (25 ± 2^oC) as well as refrigerated (5 ± 2^oC) condition for 6 months. The storage studies of new product packed in 50-micron polyethylene bags indicated that the TSS, reducing and total sugars increased with the advancement of storage period, while moisture and acidity content decreased. The rate of reactions was relatively higher at ambient temperature than refrigerated temperature. The constituents of the product produced in the current study are natural, no artificial colour and flavour is added to prepare the milk chocolate. The cost of product was calculated as per existing prices at the time of the study. It also has the market competent price therefore the product is likely to gain the attraction of consumer and improves the market trends. It is concluded that tea waste is a better substitute of a cocoa powder with an affordable initial cost and it can be used in a preparation of various chocolate products.

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