



Original Research

Physico-Chemical and Sensory Characteristics of Developed Composite Meat Chocolate

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Abstract

Composite meat chocolate, a novel product with enhanced nutritional quality and better sensory scores at room temperature was developed by replacing a part of milk chocolate. The quality of the product was assessed on the basis of pH, proximates, sensory, antioxidant activity and cholesterol content. Five samples were prepared including milk chocolate used as control and rest four samples were prepared by replacing a part of the milk chocolate with 0, 10, 20, 30 % dehydrated ground chicken meat and were respectively designated as C1, C2, T1, T2 and T3. Moisture and protein increased significantly with increase in the amount of dehydrated chicken meat powder, while pH and fat decreased significantly. A significant increase in cholesterol and decrease in antioxidant activity and sensory scores was observed in T2 and T3 treatment as compared to C1 and C2. T1 was hence chosen as best based on the results.

Key words: Cholesterol, Composite Meat Chocolate, DPPH, Proximate, Sensory, Total Phenolic Content

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Introduction

According to FSSAI (2011) regulations, composite chocolate means a product containing at least 60 per cent of chocolate by weight and edible wholesome substances such as fruits and nuts. It shall contain one or more edible wholesome substances which shall not be less than 10 per cent of the total mass of finished product. In this context the composite meat chocolate refers to the chocolate prepared by replacing a part of milk chocolate containing animal fat by dehydrated chicken meat powder. Chocolate is perceived as frequently craved food due to its unique and pleasing taste along with various beneficial health effects (Serafini *et al.*, 2003; El-kalyoubi *et al.*, 2011 and Latif, 2013). A strong craving for this food appears to be





due to its potential to arouse sensory pleasure, evoke positive emotions and alleviate depressive moods (Macht and Dettmer, 2006; Macdiarmid and Hetherington, 1995). Potential health benefits of consuming chocolates especially in preventing cardiovascular disorders, tumors and neuron related disorders owing to high antioxidant content, anti-diabetic effects, anti-inflammatory effects, anti-stress effects, anti-tumor effects, anti-obese effects and blood pressure lowering effects are well documented by Latif (2013). Although chocolate is a very good source of energy, it is a poor source of protein according to a study by Ndife *et al.* (2013). Keeping this in mind the study was designed to utilize meat, one of the best sources of protein to improve the nutritional value of milk chocolate. The study was aimed at increasing protein content of the chocolate without any adverse effect on its sensory characteristics and for development of a novel product i.e. composite meat chocolate. The composite meat chocolate prepared by replacing a part of milk chocolate containing animal fat with dehydrated ground chicken meat powder can help in improving the nutritional value of chocolate. Optimized level of animal fat was used to overcome the problem of melting away of chocolates at higher temperatures and improve its textural properties when kept at higher temperatures without any adverse effect on its sensory attributes as per Kaur *et al.* (2016). Chicken meat was chosen because of its high nutritional value, especially high protein content and its superiority over red meat based on its good fat profile according to Ashgar *et al.* (1990), Sotelo and Perez (2003). Moreover, chicken meat is highly palatable, digestible and nutritious for all age groups and are usually not associated with any social taboos. In addition, they are low in price in comparison to mutton, chevon, beef and pork. Besides this, inclusion of chicken meat reduces the cost of chocolate and also develops a product that has exceptionally enhanced shelf life of meat, although the shelf life of chocolate is compromised. In this study the developed composite meat chocolate was assessed for its various physico-chemical, proximate and sensory characteristics.

Materials and Methods

Materials Used

Various ingredients used for preparation of composite meat chocolate included cocoa powder, cocoa butter, milk solids, sugar, soy lecithin (code RM637, was procured from Hi Media), animal fat (goat fat as a source of animal fat was purchased from local market and processed in the lab by heating in hot air oven at 75°C for 15 minutes). Dehydrated ground chicken meat (commercially available dressed chicken was procured from local market. The dressed chicken was deboned manually under hygienic conditions and minced in Sirman mincer (MOD-TC 32 R10 U.P. INOX, Marsango, Italy). The minced chicken meat was spread over aluminium tray and dehydrated in oven at 75°C for 5 hours followed by grinding to convert it into powder form as per the method described by Ilansuriyan *et al.* (2015). Aluminium foil was used for packaging of product with use of LDPE around that as an outer layer. Aluminium foil and Low density polyethylene film



pouches (200 µm thickness) in natural colour were purchased from the local market. These pouches were sterilized by U.V. light and were used for packaging. The chemicals used for estimation of different parameters were of analytical grade and were obtained from standard firms (Qualigens, CDH, Hi Media etc.)

Formulation and Processing of Composite Meat Chocolate

For preparation of milk chocolate as a base for composite meat chocolate, method described by Jeffery *et al.* (1977) for manufacturing a shaped, heat-resistant chocolate product with modifications was adopted as follows: First of all milk chocolate was prepared by thorough mixing following ingredients, cocoa solids, fats(cocoa butter 90% + animal fat 10%), milk solids, sugar, emulsifier (being added after half of conching time is over) and ethyl vanillin in traces and said percentage being based on the total weight of the milk chocolate so as to produce an emulsion. The emulsion is then subjected to conching process for minimum 6 hours in a wet grinder. Now a part (10 – 30 %) of this milk chocolate emulsion is replaced by dehydrated chicken meat powder and conching is again continued for at least 2 hours. This is followed by tempering of the chocolate at 30 – 40°C for 15 – 20 minutes. Emulsion is now put into moulds of choice to obtain composite meat chocolate of desired shape. It was then wrapped in aluminium foil followed by LDPE packaging. Formulation of five chocolate samples for the optimization of dehydrated chicken meat powder in the preparation of composite meat chocolate is presented in Table 1.

Table 1: Optimization of dehydrated chicken meat powder in the preparation of composite meat chocolate

Ingredients	Milk Chocolate	C1 with 10 % cocoa butter replaced with animal fat	C2 with 10% dehydrated ground chicken meat powder	C2 with 20 % dehydrated ground chicken meat powder	C2 with 30 % dehydrated ground chicken meat powder
	(C1)	(C2)	(T1)	(T2)	(T3)
Cocoa solids	10.50%	10.50%	9.45%	8.40%	7.35%
Cocoa butter	36%	32.40%	29.16%	25.92%	22.68%
Animal fat	-	3.60%	3.24%	2.88%	2.52%
Milk Solids	11%	11%	9.90%	8.80%	7.70%
Sugar	42%	42%	37.80%	33.60%	29.40%
Lecithin	0.50%	0.50%	0.45%	0.40%	0.35%
Ethyl vanillin	0.1 % (traces)	0.1 % (traces)	0.1 % (traces)	0.1 % (traces)	0.1 % (traces)
Dehydrated ground chicken meat powder		-	10%	20%	30%

Sample Preparation

In this study five samples were prepared. First of all milk chocolate was prepared and milk chocolate with optimized animal fat as a vegetable fat replacer was prepared (containing fats in combination i.e. 90 %





cocoa butter + 10 % animal fat). Then the milk chocolate containing samples were prepared by replacing milk chocolate emulsion containing optimized animal fat with dehydrated ground chicken meat powder at 0, 10, 20 and 30 % levels and the samples were designated as control 1 (C1) i.e. milk chocolate with no animal fat and no dehydrated chicken meat. control 2 (C2) i.e. milk chocolate containing optimized animal fat but no dehydrated chicken meat, treatment 1 (T1) i.e. control 2 containing 10% dehydrated chicken meat, treatment 2 (T2) i.e. control 2 containing 20% dehydrated chicken meat and treatment 3 (T3) i.e. control 2 containing 30% dehydrated chicken meat.

Estimation of Various Parameters

pH

The pH of composite meat chocolate was determined by the method of Trout *et al.* (1992). Ten grams of sample was homogenized with 50 ml distilled water by using Ultra Turrex T 10 tissue homogenizer (Janke and Kenkel, IKA Labor Technik, Germany) for 30 seconds. The pH of the suspension was recorded by immersing the electrode of digital pH meter (product code 35613424, Oakton Instruments, Singapore) directly into the suspension.

Proximate Composition

The moisture, protein, fat and ash content of composite meat chocolates were determined by standard methods as described by AOAC (2002) using hot air oven, Kjeldahl assembly, Soxhlet extraction apparatus, muffle furnace.

Antioxidant Capacity

Determination of Total Phenolic by F-C Method

Preparation of extract: The extract was prepared according to the method of Belcak *et al.* (2009) with slight modifications. Composite meat chocolate, 10 g was defatted by ether in Soxhlet apparatus. The defatted chocolate (1 g) was centrifuged with 5 ml methanol (70%) at 3000 rpm for 10 minutes. The supernatant decanted.

Preparation of Calibration Curve using Standard Gallic Acid (GA)

Ten test tubes were taken and different concentrations of gallic acid were added into each tube ranging from 2 to 20 microlitre/ml. To each test tube 0.5 ml of Folin–Ciocalteu (FC) reagent and 5 ml of 20 % Sodium carbonate solution was added. Final volume is made 6 ml by adding distilled water. Blank consisted of Folin – ciocalteu reagent, sodium carbonate solution and distilled water and no gallic acid. The gallic acid concentration vs absorbance at 765nm was plotted and the calibration curve was drawn. The linear

correlation between standard concentration and absorbance was expressed with the equation $y = f(x)$ and r^2 value. Where, y = absorbance, x = standard concentration ($\mu\text{g/ml}$) and r^2 = correlation coefficient.

Determination of Total Phenol Content

Total soluble phenolics were determined with Folin–Ciocalteu *et al.* (1957) (FC) reagent according to the method of Yu *et al.* (2002). 0.1 ml defatted composite meat chocolate extract was added to 0.5 ml of double distilled water. To this 0.5 ml of FC reagent was added. It was followed by addition of 5 ml of 20 % sodium carbonate after 5 minutes. The mixture was shaken thoroughly and allowed to stand for 2 h or even more. The volume of the mixture was made to 6 ml with double distilled water and finally absorbance was taken at 765 nm using Systronics UV - VIS spectrophotometer. Gallic acid was used as a standard and the amount of total phenol content was calculated as mg gallic acid equivalents (GAE)/ g of defatted sample. Calibration curve of gallic acid concentration vs. absorbance at 765 nm is shown in Fig. 1.

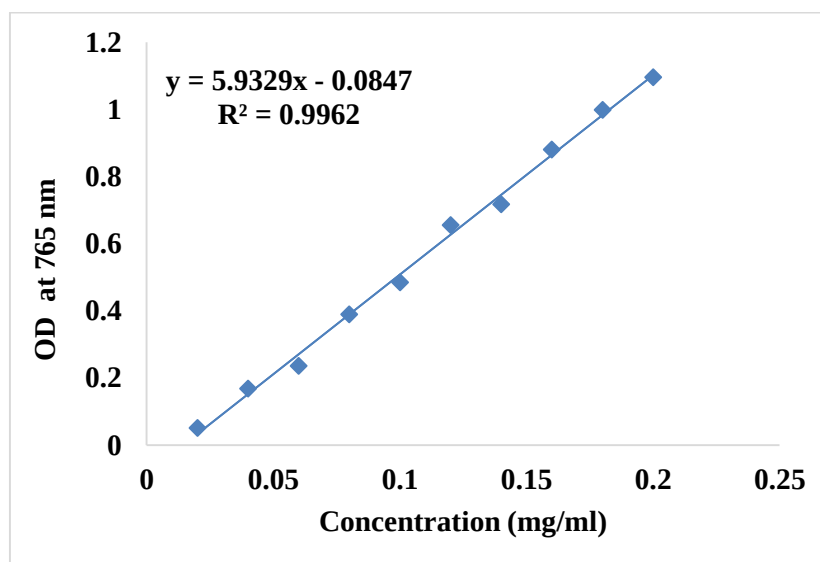


Fig. 1: Calibration curve of gallic acid concentration vs. absorbance at 765 nm

DPPH Radical Scavenging Activity

The ability to scavenge 1, 1-diphenyl-2-picrylhydrazyl (DPPH) radical by ingredients in composite meat chocolate was estimated by the method of Blois (1958) with slight modifications. The radical scavenging (% inhibition) determined by adding methanolic composite meat chocolate extract (1 ml) and DPPH solution (0.1 mM, 2ml) in test tubes. The test tubes containing the two solutions was stored in dark for 30 minutes and the absorbance was estimated at 517 nm using Systronics UV - VIS Spectrophotometer against control prepared without extract using vehicle solvent only. Ascorbic acid was used as a standard.

$$\text{DPPH}(\% \text{ inhibition}) = \frac{A_0 - A_1}{A_0} \times 100$$

Where, A_0 is absorbance of DPPH solution. A_1 is the absorbance of the reaction mixture (containing test compound and DPPH solution).

Estimation of Cholesterol

Preparation of Lipid Extract

The lipid extract of composite meat chocolate was prepared by the method of Folch *et al.* (1957). The lipid extract prepared was stored for further analysis at -18°C after addition of 0.5% of butylated hydroxyl toluene prepared in chloroform.

Assay of Total Cholesterol

Total cholesterol in the lipid extract of composite meat chocolate was estimated by Tschugaeff reaction as modified by Hanel and Dam (1995). Hundred microlitre of each cholesterol solution (1mg/ml) and lipid extract were separately taken into test tubes and evaporated to dryness. Add 4 ml of chloroform and 2 ml of ZnCl_2 reagent and 2 ml of acetyl chloride to each test tube followed by heating in water bath at 60°C for 10 minutes. Blank was prepared by adding 4 ml chloroform, 2 ml of ZnCl_2 reagent and 2 ml of acetyl chloride in a test tube and it was heated along with samples at 60°C . The optical density of the coloured complex was measured at 528 nm in Systronics UV - VIS Spectrophotometer and expressed as mg/100g of composite meat chocolate. Cholesterol concentration and corresponding absorbance at 528nm was plotted in a graph and the calibration curve was drawn as shown in Fig. 2. The linear correlation between standard concentration and absorbance was expressed with the equation $y = f(x)$ and r^2 value. Where, y = absorbance, x = standard concentration ($\mu\text{g/ml}$) and r^2 = correlation coefficient.

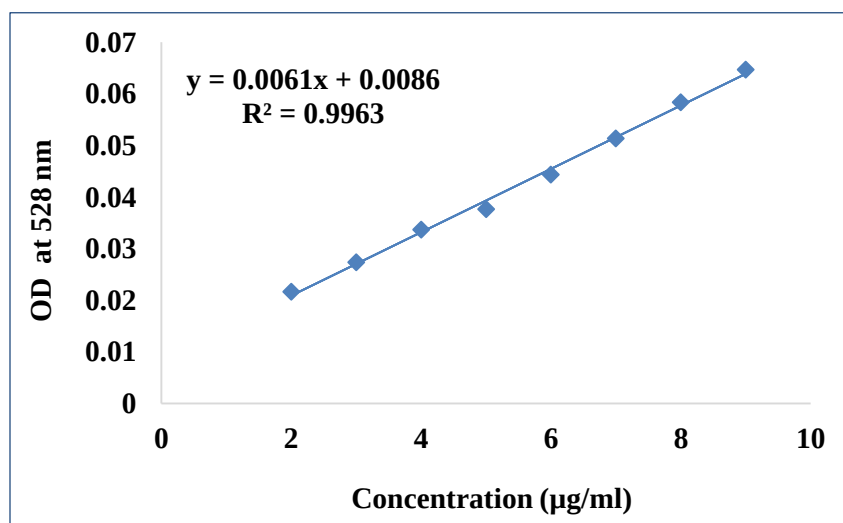


Fig. 2: Calibration curve of cholesterol concentration vs. absorbance at 528 nm

Sensory Evaluation

Ten panelists rated the intensity of each sensory descriptor for each sample, in triplicate. The acceptance of the chocolate samples was conducted with semi-trained panelist from university campus. A nine-point structured hedonic scale (1= disliked extremely and 9 = liked extremely) was used in the acceptance test to evaluate the appearance, taste, aroma, hardness, mouthfeel and overall acceptability of the samples as described by Iwe (2010).

Statistical Analysis

The result was analyzed statistically for analysis of variance and least significant difference tests as per Snedecor and Cochran (1997). In significant effects, least significant difference was calculated at appropriate level of significance for a pair wise comparison of treatment means.

Result and Discussion

The mean values of pH, proximate analysis and cholesterol content are presented in Table 2.

Table 2: Effect of dehydrated chicken meat powder on pH, proximate parameters and cholesterol content of milk chocolate (Mean $\pm$ SE) *

Parameter	C1	C2	T1	T2	T3
pH	6.76 $\pm$ 0.03 ^c	6.78 $\pm$ 0.02 ^c	6.62 $\pm$ 0.05 ^b	6.49 $\pm$ 0.03 ^a	6.40 $\pm$ 0.03 ^a
Moisture (%)	1.50 $\pm$ 0.02 ^a	1.51 $\pm$ 0.03 ^a	2.11 $\pm$ 0.04 ^b	2.65 $\pm$ 0.03 ^c	3.34 $\pm$ 0.05 ^d
Protein (%)	7.23 $\pm$ 0.33 ^a	7.17 $\pm$ 0.24 ^a	13.84 $\pm$ 0.29 ^b	19.30 $\pm$ 0.17 ^c	25.48 $\pm$ 0.56 ^d
Fat (%)	40.62 $\pm$ 0.19 ^d	40.03 $\pm$ 0.22 ^d	37.22 $\pm$ 0.24 ^c	35.59 $\pm$ 0.18 ^b	33.54 $\pm$ 0.19 ^a
Ash (%)	2.37 $\pm$ 0.04 ^d	2.35 $\pm$ 0.05 ^d	1.89 $\pm$ 0.03 ^c	1.54 $\pm$ 0.04 ^b	1.38 $\pm$ 0.02 ^a
Carbohydrate (%)	48.54 $\pm$ 0.49 ^d	49.24 $\pm$ 0.23 ^d	44.92 $\pm$ 0.39 ^c	40.89 $\pm$ 0.22 ^b	36.24 $\pm$ 0.67 ^a
Cholesterol(mg/100g)	10.5 $\pm$ 1.11 ^a	12.75 $\pm$ 1.5 ^a	21.38 $\pm$ 1.46 ^{ab}	30.84 $\pm$ 1.94 ^{bc}	39.14 $\pm$ 2.15 ^c

*Mean SE with different superscripts in a row differs significantly ($p < 0.05$). $n = 6$ for each treatment.

The results showed significant ($P < 0.05$) decrease in pH, fat, ash and carbohydrates with increase in the level of dehydrated chicken meat powder in milk chocolate. Moisture content and protein content increased significantly ($P < 0.05$) with increase in level of dehydrated chicken meat powder in milk chocolate. The decrease in pH was significant ($P < 0.05$) and it might be due to lower pH of chicken meat than chocolate (FDA, 2015). The mean value of moisture content and protein content increased significantly ($P < 0.05$) in all treatments with increase in the level of dehydrated chicken meat powder as compared to control because of higher moisture and protein content in dehydrated chicken meat powder as compared to milk chocolate. The mean values for fat and carbohydrates decreased significantly ($P < 0.05$) with the increase in the level of dehydrated chicken meat powder and it is because of low fat and carbohydrate content in dehydrated chicken meat powder as compared to milk chocolate. The proximate results were in accordance with Ilansuriyan *et al.* (2015) and Ndife *et al.* (2013). Cholesterol content increased significantly ($P < 0.05$) in T2

and T3 as compared to control which might be because of higher cholesterol content in dehydrated chicken meat powder as compared to milk chocolate (USDA, 2016) and due to inclusion of animal fat in the developed composite meat chocolate.

The mean values for sensory attributes are presented in Table 3. The scores for sensory attributes except for appearance declined significantly ($P < 0.05$) with increase in the amount of dehydrated chicken meat powder. The mean values for all sensory scores of T1 was comparable to control and were liked very much except for mouth feel which was liked moderately.

Table 3: Effect of dehydrated chicken meat on sensory parameters of milk chocolate (Mean $\pm$ SE)*

Parameter	C1	C2	T 1	T 2	T 3
Appearance	8.55 $\pm$ 0.24	8.52 $\pm$ 0.21	8.51 $\pm$ 0.19	8.51 $\pm$ 0.20	8.48 $\pm$ 0.26
Taste	8.45 $\pm$ 0.28 ^c	8.32 $\pm$ 0.17 ^c	8.22 $\pm$ 0.20 ^c	7.14 $\pm$ 0.31 ^b	5.71 $\pm$ 0.33 ^a
Aroma	8.50 $\pm$ 0.19 ^c	8.22 $\pm$ 0.16 ^c	8.16 $\pm$ 0.22 ^c	7.04 $\pm$ 0.40 ^b	6.06 $\pm$ 0.35 ^a
Hardness	8.23 $\pm$ 0.15 ^c	8.18 $\pm$ 0.23 ^c	8.10 $\pm$ 0.25 ^c	7.13 $\pm$ 0.31 ^b	5.89 $\pm$ 0.27 ^a
Mouth feel	8.11 $\pm$ 0.30 ^c	7.89 $\pm$ 0.34 ^c	7.85 $\pm$ 0.28 ^c	6.63 $\pm$ 0.30 ^b	5.42 $\pm$ 0.33 ^a
Overall acceptability	8.28 $\pm$ 0.31 ^c	8.15 $\pm$ 0.24 ^c	8.15 $\pm$ 0.23 ^c	7.18 $\pm$ 0.29 ^b	5.48 $\pm$ 0.25 ^a

*Mean SE with different superscripts in a row differs significantly ($P < 0.05$). Mean values are scores on 9 point descriptive scale. $n = 21$ for each treatment.

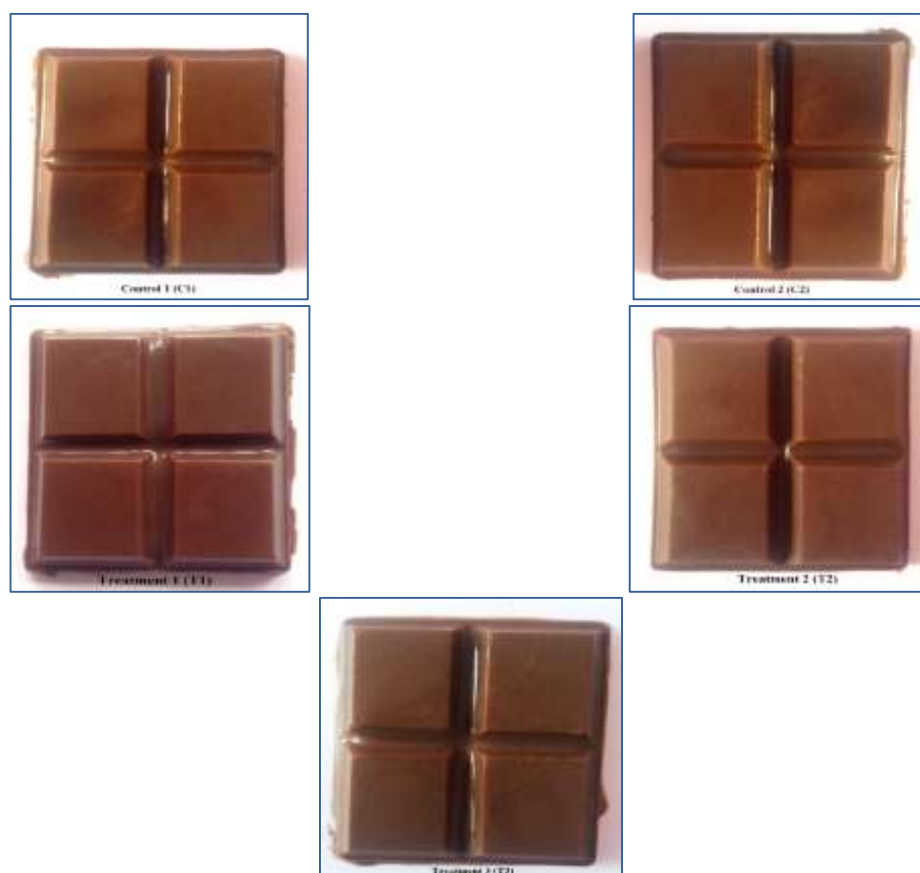


Fig.: Photographs of composite meat chocolate containing dehydrated chicken meat powder at different levels.

All sensory scores except appearance scores decreased significantly ($P < 0.05$) in T2 and T3 and the decrease was attributed to the change in sensory qualities of milk chocolate containing animal fat after incorporation of dehydrated chicken meat powder. There was slight increase in bittersweet taste in T2 and T3, however the consumers who have liking for dark chocolates liked the composite meat chocolate with higher level of dehydrated chicken meat powder, but dark chocolate was not taken as control in the study. Fig. 3 represents the antioxidants activity of developed composite meat chocolate samples.

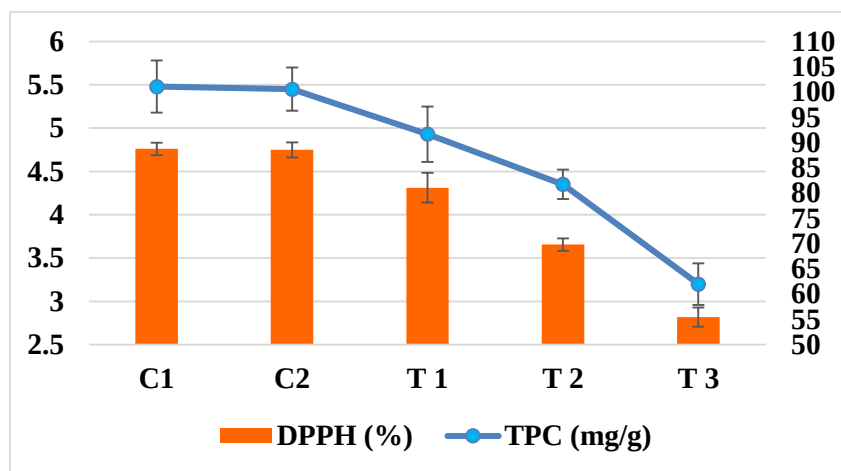


Fig. 3: Effect of dehydrated chicken meat on antioxidant activity of milk chocolate

The results showed that the mean values of total phenolic content and DPPH radical scavenging activity was significantly ($P < 0.05$) less in T1, T2 and T3 as compared to Control (C). High antioxidant activity of chocolate owing to one of its ingredients i.e. cocoa powder as reported by Ortega *et al.* (2008) and very low antioxidant activity of chicken meat as reported by Singh *et al.* (2014) might be a valid reason behind such results. Based on the results treatment 1 (T1) i.e. chocolate containing 10 % dehydrated chicken meat powder was chosen as best among the treatments under study.

Conclusion

Milk chocolate is liked by not only kids but adults too. It is a very good source of energy that is light in weight and easy to carry. Hence it was once mostly a part of soldier's ration and sports person's diet. Low protein content in chocolate was tempting enough to utilize meat, a rich protein source in the form of dehydrated chicken meat powder in the preparation of composite meat chocolate. The novel product has improved nutritional value and reduced cost too. This will help in alleviating the problem of malnutrition in kids even from lower economical group. According to results obtained in the study, milk chocolate replaced with dehydrated chicken meat powder at 10% level was accepted as its sensory performance was close to the control i.e. milk chocolate.



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