Original Research Article

Development of Tricolour Chocolate from Powder Extract of Drumstick Leaves and Carrots

Abstract

Drumstick leaves and carrots need to be part of our diet and incorporating them into chocolate together leads to a newer innovation in the field of food science and technology. The formulated tricolour chocolate may provide us the convenience to have these important nutritional components and along with the acceptable taste we can achieve its utmost health benefits as well. Hence, the research leads towards the formulation of a newer combination of tricolour chocolate aims to provide convenience and added health benefits for human consumption.

Keywords
Carrots, Drumstick leaves, Functional food, Health benefits, Tricolour chocolate

1. INTRODUCTION

The significance of functional food has been acknowledged in modern perceptions of nutrition. Such foods offer numerous physiological advantages and lower the risk of chronic illnesses in addition to their fundamental nutritional purposes. These food products either remove an ingredient that has a negative impact on health or or include an ingredient that has a good impact (Zaragoza.F et al., 2010). The demand for food items containing functional ingredients has expanded drastically due to their excellent nutritional value. Consuming foods rich in phytochemicals may help prevent cancer, heart disease, neurological disorders, and birth defects (Blancquaert et al., 2010; Liu, 2013).

Moringa oleifera (drumstick) is a highly nutritious vegetable grown around the world, including India, Pakistan, Hawaii, the Philippines, and many African countries (Anwar *et al.*, 2005). The tree is known locally as the *Saijihan, Kelor, Marango, Mlonge, Horseradish, Benzolive, Drumstick, and Sahjan trees* (Fahey, 2005). The leaves of the *Moringa oleifera* plant are known for their high antioxidant activity and contain vitamins and phenolic components including kaempferol and quercetin (Coppin.JP et al., 2013). It contains several micronutrients, has been claimed to be an excellent source of carotene, protein, vitamin C, minerals, and natural antioxidants such as ascorbic acid, flavonoids, phenolics, and carotenoids (Sonawane.SV and Rana.K, 2022; Chumark *et al*., 2008). Because of its multiple uses, especially in nutrition and medicine, moringa leaves are referred to as magic plant leaves or are known as pharmacy plants too. (Sonawana.SV and Rana.K, 2022).

Carrots are considered as a multinutritional food source that are high in fibre, minerals, and natural bioactive components such ascorbic acid, polyacetylenes, phenolics, and carotenoids (Ahmad et al., 2019). Carrots can therefore be included to food products as a functional component to boost its nutritional and biological value (Ergun, 2018). The seasonally available root vegetable carrot (Daucus carota L.) is rich in nutrients. Drying the carrot may be a useful method of extending its shelf life (Al-Amin et al., 2015). Carrots are very nutritious and have several medicinal and health benefits. The carrot storage root is high in minerals and antioxidants, as well as

dietary fiber, vitamins, and carotenoids (Arscott, S. A. & Tanumihardjo, S. A., 2010; Nicolle, C. et al., 2004). It's surface area, porosity, and strength all noticeably increase when it is processed into a powder. This results in a product that is easily absorbed and digested by humans (Zheng and Xia, 2006; Ma et al., 2008; Gong et al., 2006).

White chocolate is a confectionery product made of sugar, milk solids, cocoa butter, lecithin, and vanillin where the particles of sugar and milk solids are covered by a continuous fatty phase (mainly cocoa butter). Milk solids commonly consist of whole milk powder, and in some formulations skimmed milk powder, whey powder, and lactose can be used. To be named "white chocolate", white chocolate must include whole milk powder and cocoa butter in its composition, therefore it does not contain cocoa products other than cocoa butter (Loncarevic.I et al., 2021; Vercet, 2003). Compared to other forms of chocolate, white chocolate is less functional since it does not contain cocoa in its formulation. It is possible to improve the functionality of white chocolate by incorporating different natural extracts into the recipe (Loncarevic.I et al., 2018,2019).It was used here for blending the main two ingredients i.e., drumstick leaves and carrots.

2. MATERIALS and METHOD

Sample Procurement

The sample used for the work were white compound chocolate (obtained from local bakery near BBAU, Lucknow), drumstick leaves (obtained from BBAU campus which was authenticated by the Horticulture department), carrots and almonds (obtained from local market near BBAU, Lucknow).

Tricolour Chocolate Preparation

The chocolate was made in order to enhance the acceptability of moringa and addition of both carrot and drumstick leaves increased the functionality of the white compound chocolate along with almonds making it nutritionally better. Once the samples were collected the further process was carried out. Moringa leaves were collected and washed thoroughly to remove any kind of contamination. Then they were cleaned using a clean cloth. The leaves were dried in a dehydrator for a duration of 5 hours at 50℃. It was then finely grinded and turned into powder. Carrots were washed and cleaned properly and then were grated. They were then dried in a dehydrator at 50℃ for a duration of 6 hours. They were then grinded and turned into fine powder. The white compound chocolate was melted at high temperature using a double boiler. The almonds were roasted and grinded. They were then added to the chocolate. The moringa powder and carrot powder were added to the melted chocolate. The constant stirring of the chocolate and powder was done so that they are well combined. Then the chocolate was poured in the mold and chilled till the texture turns hard. Finally, the chocolates were wrapped in aluminium foils and stored in the refrigerator at 3-6℃.

Table 1 – Formulation of Tricolour Chocolate

Ingredients	T_1	T_2	T_3	T_4
Drumstick leaves	0 gm	5 gm	10 gm	15 gm
Carrot powder	0 gm	5 gm	10 gm	15 gm
White chocolate	100 gm	100 gm	100 gm	100 gm
Almonds	20 gm	20 gm	20 gm	20 gm

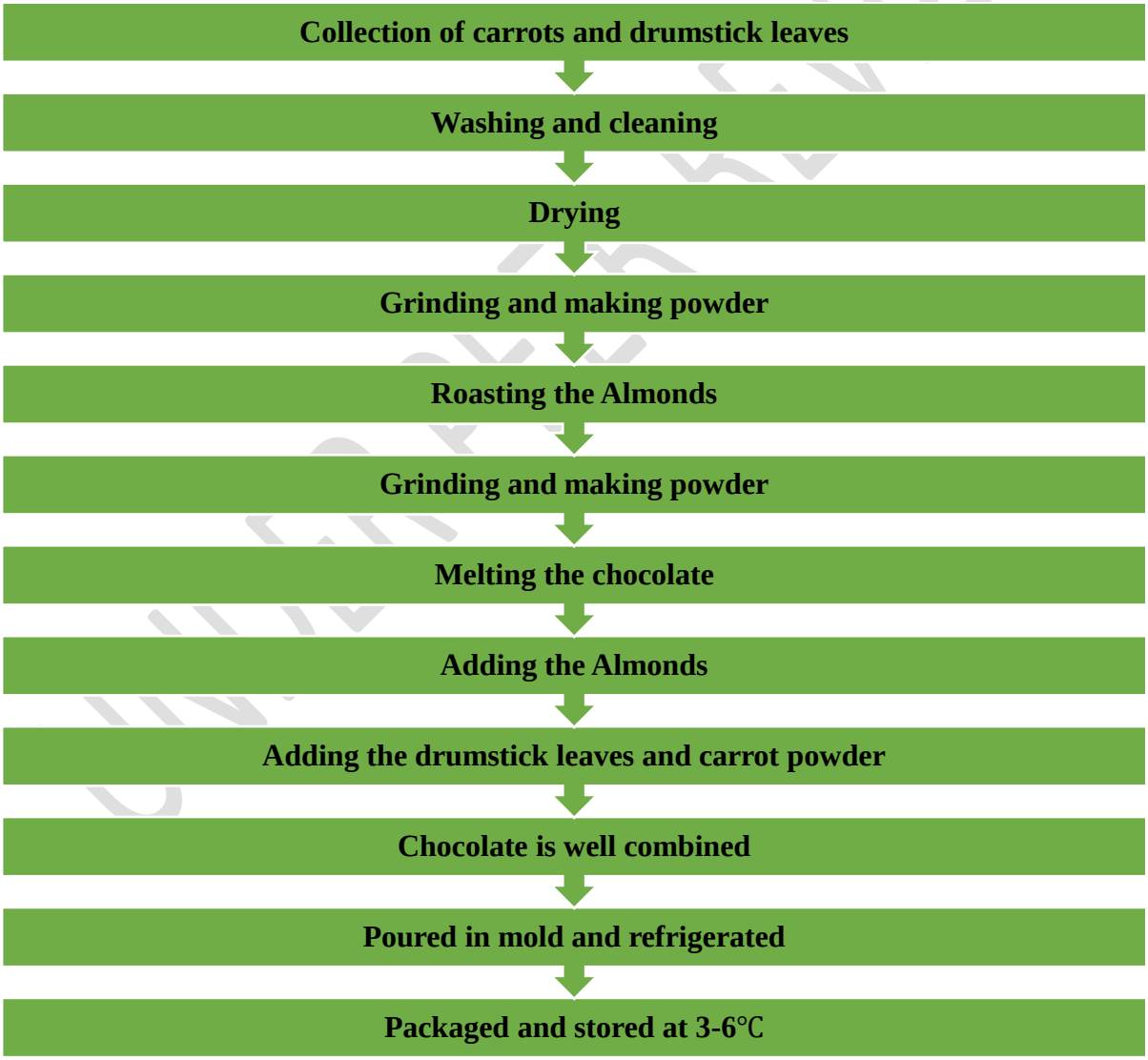


Fig. 1- Flow chart for preparation of Tricolour chocolate

2.1 Physiochemical Analysis

The physiochemical properties such as pH, TSS (Total Soluble Solids) and acidity were examined.

i. pH

A pH meter (Labtronics Model LT – 501 microprocessor pH meter) was used to determine the pH value of each sample. For checking the pH value of the chocolate, a solution was prepared using distilled water. pH meter was dipped in beaker and record was taken for both the control sample as well as prepared tricolour chocolate (Patel, M., et. al 2022).

ii. Total Soluble Solids (TSS)

With the help of a hand refractometer (MA 871, Germany) with a range of 0-85% Brix, the TSS of each treatment was calculated and expressed in Brix following the temperature correction at 24◦ (El-Gioushy et al., 2022). A drop of samples was respectively placed over the prism cleaned with distilled water and the percentage of brix was read and recorded (Lakshmi et al., 2018) (Patel, M., et. al 2022).

iii. Acidity

A fractional of samples was taken and dissolved in distilled water and titrated against 0.1 N NaOH with phenolphthalein as a marker to the endpoint, and stated as (%) of ascorbic acid. The end point is denoted by the appearances of pink colour (Hayat et al., 2005) (Patel, M., et. al 2022). For calculating the acidity, following formula was used:

$$\text{Titrable acidity} = \frac{\text{ml NaOH} \times \text{N NaOH} \times \text{meq. Weight of acid}}{\text{sample titrated}} \times 100$$

Where,

meq = milli equivalent

meq weight of ascorbic acid = 0.176

2.2 Proximate Analysis

i. Moisture

The AOAC technique (2000) was used to examine the moisture content of the samples. Sample weighing 5 g was then placed in a covered dish that had been dried previously. After the sample was weighed, it was dried for a duration of two hours at 105 ± 1 °C in a hot air oven. After the dish containing the dried sample was placed in the desiccator, it was allowed to cool to room temperature and weighed (Patel, M., et. al 2022). Based on weight loss, the percentage of moisture content was noted.

$$\text{Moisture Content (\%)} = \frac{W1 - W2}{W} \times 100$$

Where,

W = Weight of sample

W1 = Weight of sample + moisture dish

W2 = Weight of dried sample + moisture dish

ii. Crude Protein

Crude protein was estimated with the help of micro-Kjeldhal method AOAC (2000).
The protocol used here was validated by Patel, M., et. al 2022 and was followed with slight modification.

$$\text{Nitrogen (\%)} = \frac{(S-B) \times 14 \times N \times 100}{W \times 1000}$$

Conversion factor 5.7 was used to calculate % Protein

Crude Protein % = Nitrogen (%) × 5.7

Where,

N= Normality of standard HCl solution

W= Weight of sample taken (g)

S= Volume of standard acid (0.01 N HCl) used for titration (ml)

B= Volume of 0.01 N HCl used for blank (ml)

iii. Crude fat

Crude fat was estimated with the help of standard method of AOAC (2000).
With slight modification the protocol followed here was validated by Patel, M., et. al 2022.

$$\text{Fat (\%)} = \frac{W2 - W1}{W} \times 100$$

Where,

W2 = Weight of thimble + sample (before extraction)

W1 = Weight of thimble + sample (after extraction)

W = Weight of sample

iv. Ash

Ash content in samples was estimated with the help of standard method of AOAC (2000).

About 2 g of sample was weighed and was put in pre-weighed crucible, dried at 100 °C for 10 h and weighed. The weighed sample was charred till smoke ceases. The crucible was then transferred to muffle furnace maintained at 550±5 °C and incinerated until light grey ash was obtained. The crucible was then cooled in desiccator and weighed (Patel, M., et. al 2022). The results were reported on dry weight basis.

$$\text{Ash (\%)} = \frac{W3 - W2}{W_1} \times 100$$

Where,

W1 = Weight of the sample

W2 = Weight of empty Crucible

W3 = Weight of crucible + ash

v. Crude fibre

Crude fibre was estimated with the help of standard AOAC (2000) method.

The protocol used here was validated by Patel, M., et. al 2022 and was followed with slight modification.

$$\text{Crude Fiber (\%)} = \frac{W2 - W1}{W} \times 100$$

Where,

W = Weight of Sample

W1 = Weight of crucible+ weight of treated sample after oven drying.

W2 = Weight of crucible + weight of sample after ashing.

vi. Carbohydrates

Available carbohydrates content was calculated by difference method AOAC (2000) on dry basis (Patel, M., et. al 2022) using following formula:

Total carbohydrates = 100 – (fat + protein + ash + fiber + moisture)

2.3 Sensory Evaluation

The sensory evaluation was done on the basis of composite scoring test. 30 semi-trained panelist members evaluated the developed samples. Panellists (of the institute) were asked to assess the all samples for overall acceptability. Sensory attributes like colour, aroma, consistency, flavour and absence of defects were used for evaluation.

2.4 SEM (A scanning electron microscope)

Sample preparation was done with the help of a method described by McMullan (2006). The protocol used here was validated by Patel, M., et. al 2022 and was followed with slight modification.

2.5 EDS (Energy Dispersive X-Ray Spectroscopy)

It is used for giving the elemental identification and quantitative compositional information of the developed product. With slight modification the protocol followed here was validated by Patel, M., et. al 2022.

3. RESULT and DISCUSSION

3.1 Physiochemical Analysis

The physiochemical properties such as Total Soluble Solids (TSS), pH and Acidity were examined.

Table 2 - Result of Physiochemical Analysis

Parameter	T_0	T_1
TSS	3.8 ± 0.02 °Brix	3.3 ± 0.04 °Brix
pH	5.7 ± 0.01	6.2 ± 0.02
Acidity	0.03 ± 0.01	0.52 ± 0.04

T_0 = Control sample & T_1 = Prepared tricolour chocolate

3.2 Proximate Analysis

The proximate analysis for moisture, ash, fat, crude fibre, protein and carbohydrate was done.

Table 3 - Result of Proximate Analysis

Parameter	T_0 (%)	T_1 (%)
Moisture	1.5 ± 0.04	1.3 ± 0.01
Ash	10.23 ± 0.03	14.28 ± 0.06
Fat	35.3 ± 0.02	29.9 ± 0.03
Crude fibre	7.85 ± 0.04	10.1 ± 0.01
Protein	6.1 ± 0.03	11.16 ± 0.02
Carbohydrates	39.02 ± 0.06	33.36 ± 0.05

T_0 = Control sample & T_1 = Prepared tricolour chocolate

After analysis it was found that the TSS of the developed chocolate was 3.33 ± 0.04 °Brix, pH was 6.2 ± 0.02 and the acidity was 0.52 ± 0.04 on the other hand the TSS of the control sample was found to be 3.8 ± 0.02 °Brix, pH was 5.7 ± 0.01 and the acidity was 0.03 ± 0.01.

After analysis the moisture content was found to be 1.3 ± 0.01 %, ash content was 14.28 ± 0.06 %, fat content was 29.9 ± 0.03 %, crude fibre content was 10.1 ± 0.01 %, protein content was 11.16 ± 0.02 % and the carbohydrate content was found to be 33.36 ± 0.05 % in 100gms of the developed tricolour chocolate. On the other hand, the moisture content of the control sample was found to be 1.5 ± 0.04 %, ash content was 10.23 ± 0.03 %, fat content was 35.3 ± 0.02 %, crude fibre content was 7.85 ± 0.04 %, protein content was 6.1 ± 0.03 % and the carbohydrate content was found to be 39.02 ± 0.06%.

The moisture and ash content of the developed tricolour chocolate was more in comparison to the developed *Moringa oleifera* chocolate by Sonawana.SV and Rana.K, (2022). The moisture content of the developed tricolour chocolate was almost similar to the developed nutritional bar with *Moringa oleifera* and *Ocimum sanctum* leaves by Doshi.JP & Todkar.A (2023) while the ash content was high in comparison to the later. The protein content was little bit higher in the developed tricolour chocolate and the fat and carbohydrate content was lower in comparison to the developed *Moringa oleifera* chocolate by Sonawana.SV and Rana.K, (2022). The protein content of the developed tricolour chocolate was higher in comparison to the developed nutritional bar with *Moringa oleifera* and *Ocimum sanctum* leaves by Doshi.JP & Todkar.A (2023).

3.3 Sensory Evaluation

A sensory evaluation of the developed Tricolour chocolate was conducted and the result was obtained which is shown below in the form of radar graph.

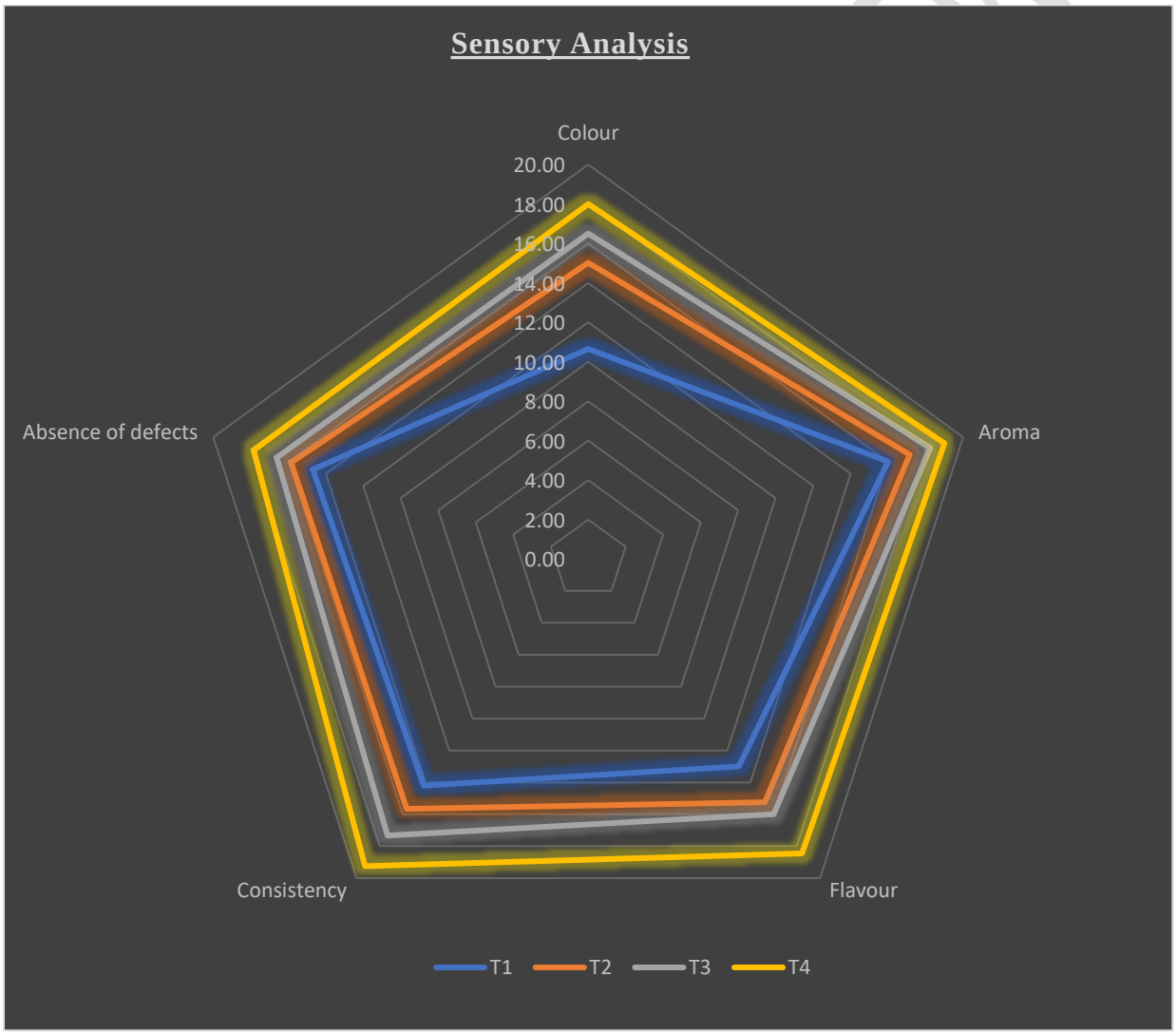


Fig.2 – Result of Sensory Analysis

T_1, T_2, T_3 and T_4 were the developed chocolate with different composition and formulation and were used for sensory analysis. T_4 got the maximum score. The developed Tricolour chocolate with 10% drumstick leaves and 15 % carrot powder was preferred by most and was used for further analysis.

3.4 SEM (A scanning electron microscope)

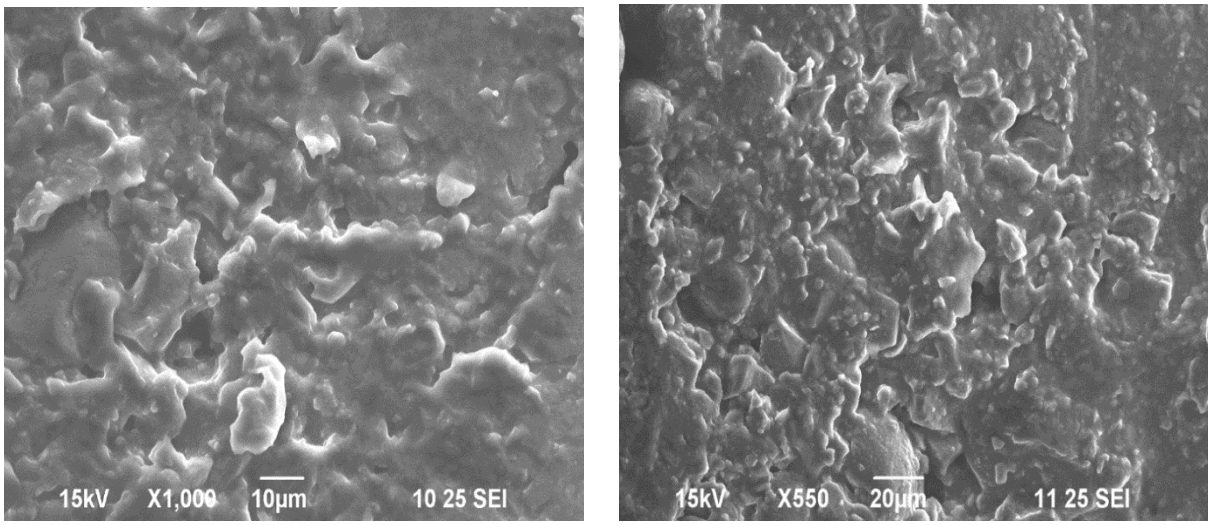
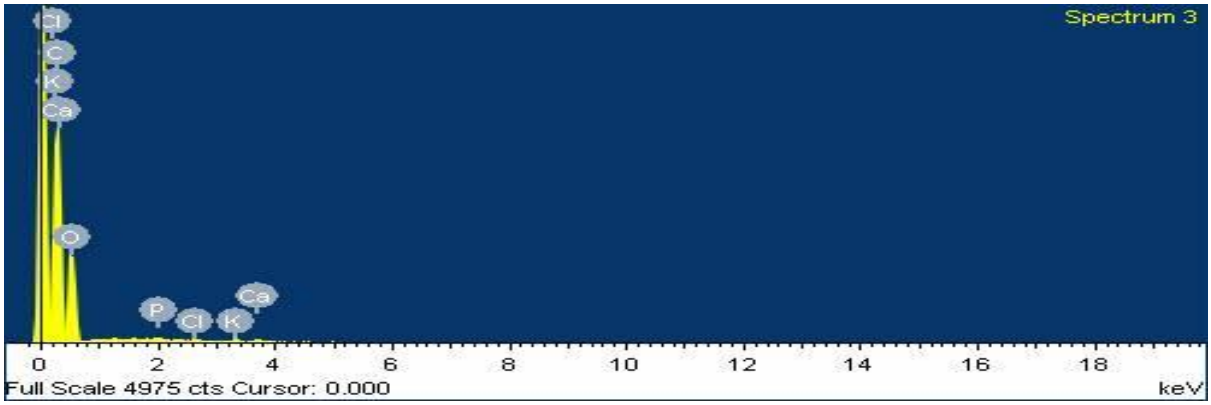


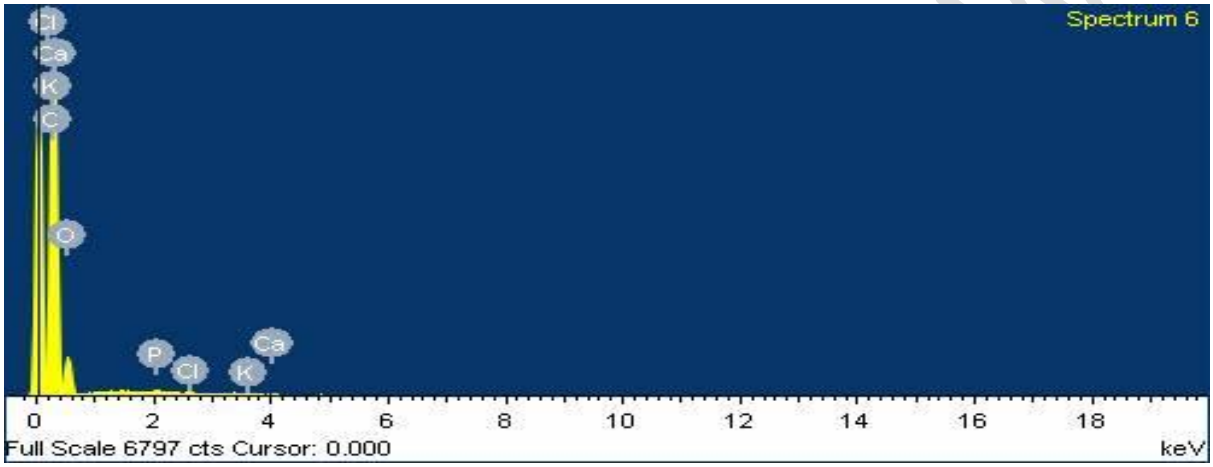
Fig. 3 – Result of SEM for the control sample T_0 and the prepared Tricolour chocolate T_1 respectively

3.5 EDS (Energy Dispersive X-Ray Spectroscopy)



Element	Weight%	Atomic%
C K	49.56	56.93
O K	49.55	42.73
P K	0.23	0.10
Cl K	0.12	0.05
K K	0.30	0.11
Ca K	0.23	0.08
Totals	100.00	

Fig. 4 – Result of EDS for the control sample T_0



Element	Weight%	Atomic%
C K	63.45	70.09
O K	35.69	29.59
P K	0.24	0.10
Cl K	0.20	0.07
K K	0.24	0.08
Ca K	0.18	0.06
Totals	100.00	

Fig. 5 – Result of EDS for the prepared Tricolour chocolate T_1

CONCLUSION

Drumstick leaves and carrots are of a lot importance with respect to our health. They are filled with numerous vital nutrients. The drumstick leaves are rich in minerals, vitamins and other essential phytochemicals. Extracts from the leaves are used to treat malnutrition, augment breast milk in lactating mothers. It is used as potentialantioxidant, anticancer, anti-inflammatory, antidiabetic and antimicrobial agent (Gopalkrishnan et. Al 2016). Carrot contains appreciable concentrations of B1, B2 and B6 vitamins along with carotenes and dietary

fibres (Manjunatha *et al*., 2003, Bao & Chang, 2006). Drumstick leaves and carrots need to be included in our diet and incorporating them into chocolate together leads to a newer innovation in the field of food science and technology.

Addition of carrot and drumstick leaves into the white chocolate is a great idea in order to provide the benefits of carrot and drumstick leaves in the form of chocolate. This enhances the functionality of the white chocolate making it a better product. Incorporation of the main ingredients (carrot and drumstick leaves) along with almonds into the white chocolate increases the acceptability of the carrot and drumstick leaves among the people of all age groups. Hence it becomes a mixture of health as well taste.

The formulated tricolour chocolate may provide us the convenience to have these important components and along with the acceptable taste we can achieve its utmost health benefits as well. Hence, the research leads towards the formulation of a newer combination of tricolour chocolate aims to provide convenience and added health benefits for human consumption.

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