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INCORPORATION OF NATURALLY EXTRACTED COLORS (VEGETABLES) AND ITS PHYSIO-CHEMIAL PROPERTIES ON COOKIES

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ABSTRACT

The use of natural food colorants has gained popularity due to consumer demand for healthier and more sustainable food products. In this study, natural colors extracted from vegetables like carrot , beetroot , mint and palak were employed to impart color to cookies aiming to eliminate the need for synthetic food dyes. Nutritive value, microbial content and sensory attributes of the cookies were also assessed. It was inferred from the sensory scores that the carrot extract incorporated cookies had the highest score of 4.532±0.658 followed by beetroot, palak and mint extracts incorporated cookies with scores of 4.168±0.553, 4.087±0.540 and 3.912±0.526 respectively. The microbial analysis revealed that 20ml of the carrot color incorporated cookies had the highest total plate count of 8 x 10 cfu/g on 45th day and the least plate count of 2 x 10 cfu/g was observed in 20 ml of the palak, mint and beetroot incorporated cookies.

Keywords: Natural food colors, Carrot extract, Beetroot extract, Palak extract, Mint extract , Shelf life

INTRODUCTION

The global sales of synthetic food colors would reach a Compound Annual Growth Rate (CAGR) 6% between 2022 - 2023 in comparison to the 4.8% CAGR registered from 2017 - 2022. The growth in the global food colors market is driven by growing demand for innovative, unique looking food dishes and rapid expansion of food and beverage industry worldwide. Currently, synthetic food colors account for around 30% of sales by value and 40% by volume of the overall food color market (2021). Some of the common synthetic food colors used are tartrazine, sunset yellow, amaranth, allura red, quinoline yellow, brilliant blue and indigo carmine. The global natural food colors market is anticipated to grow at a CAGR of around 5% during 2019-2024.

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Some artificial food dyes, particularly Blue 1, Red 40, Yellow 5 and Yellow 6, may cause allergic reactions in sensitive individuals. (Dey & Nagababu,2022). Some people are allergic to certain synthetic food colors, such as tartrazine (Yellow 5) or cochineal extract (Carmine) that causes mild itching to severe anaphylaxis. It was observed that the ingestion of artificial food colors causes hyperactivity in children leading to Attention Deficit Hyperactivity Disorder (ADHD). It was also noted that asthma and respiratory issues were caused due to intake of tartrazine (Yellow 5) and sunset yellow (Yellow 6). Some synthetic food colors, such as Red 3 (erythrosine) have been shown to cause carcinogenic properties in animal studies conducted by International Agency for Research on Cancer (IARC) which classified Red 3 as a human carcinogen.

Some synthetic food colors like Red Dye 40 (Allura Red) causes estrogenic activity to be disrupted which causes hormonal imbalance in the body (Slurrp Editorial, 2023). The major purpose of adding food colorants to food products is to give an appealing appearance of the finished products, which attacts the consumers and improves the perception of colors that matches the flavor during consumption. The natural food color obtained by extraction of plant materials consists of pigments which are rich in nutritional and aromatic properties. The purpose of coloring is to replace the color lost during food processing. Therefore, natural food coloring agent is applied as a food additive in both commercial foods and domestic cooking purposes. Currently the companies in India that extract natural colors are Minimalist bakers, Butternutbakes (beetroot extract) hersheyland (carrot extract) Bakersville, colourmist (mint colorant) and Sprig natural food color (spinach green).

With this background, a study was undertaken to compare and select the best natural colour from common vegetables for incorporation in cookies.

MATERIALS AND METHODS

The vegetables chosen for natural color extracts were carrot (*Daucus carota*), beetroot (*Beta vulgaris*), mint *(Mentha arvensis*) and palak (*Spinacia oleracea)* that are safe to cook and also enhances the color of the food. These common vegetables were selected due to the possibility of extraction of natural colors, high nutrient content and being vegan products.

Phase 1: Collection of Natural Colors from Vegetables

The natural colors from vegetables were extracted by washing the vegetables, chopping them to small pieces, blending in a mixer and then straining the liquid. The natural liquid color was

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added to the dough at different concentrations.

Fig 1: Extraction of liquid color from vegetables

Phase 2: Preparation and Standardisation of Cookies

The cookies were prepared by following a proportion of common ingredients of 100g of maida, 8g of corn flour, 75g of sugar and 75g of butter. Butter, sugar and the specific liquid extracts (carrot, beetroot, mint and palak with different concentrations of 15, 20 and 25ml – mentioned as D1, D2 and D3 respectively) were mixed thoroughly along with a pinch of baking soda; and baking powder with maida and corn flour. The dough was kneaded completely and allowed to set for 15 minutes. The dough was moulded into desired shape. The molded cookies were then placed in a greased tray with butter and maida, and baked in oven at 150^{o}C for 20 minutes. After cooling, cookies were packed and sealed in a polythene pouches of 200 gauge.

Fig 2: Preparation of cookies

i. Evaluation of Cookies

The natural colors were extracted from the selected vegetables and the concentrations were standardized. For standardization of dose of natural colors, trials were carried out at varied concentrations by using 15, 20 and 25 ml concentrations. After baking no significant difference was observed in the color intensity of the cookies in all the three dosages of carrot

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extracts.Initial trials were done to standardise the effective dose of colour extracts, using 5, 10 and 15ml of the liquid extract and incorporated into the cookies. Since the intensity of color in cookies was not sufficient in carrot and mint the trail was repeated with higher doses i.e., 10, 15 and 20 ml.

Carrot Extract **Beetroot extract** **Mint extract** **Palak extract**

PLATE 1

Cookies coloured with mint , palak, carrot and beetroot extracts

PLATE 2

Sensory evaluation of cookies was done based on the 5 point hedonic rating scale namely appearance, flavor, taste, color and overall acceptability were organoleptically evaluated. The testing was done by finding the differences based on consumer preferences and it was statistically analyzed using CRD (Completely Randomized design). Hence in the present study, the sensory evaluations were carried out with 30 members and their scores were evaluated for the average and its standard deviation (SD). The best colour dose was selected for each extract based on sensory scores. Stored cookies were then analyzed for their nutritional properties, shelf life and microbial counts.

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Phase 3: Shelf Life, Nutrition and Microbial Study of Cookies

Cookies were packed in polyethylene pouches and kept for 45 days at room temperature. Nutritional analysis, microbial study and enumeration of bacterial count of cookies were done at 15 days interval (0, 15, 30 and 45th day of storage).The nutrient analysis were done for

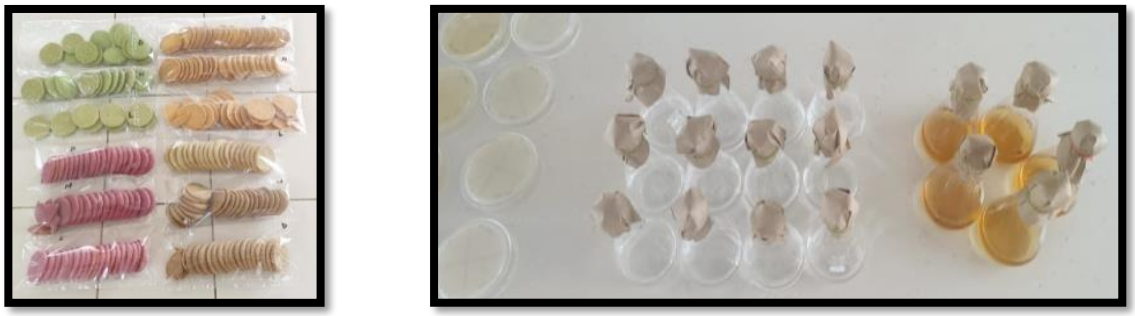

Fig : 3 Shelf life and microbial study

Moisture, Protein, Fat, Vitamin A by AOAC (1990) Official method of Analysis and microbial study were done by using Total plate count by Serial dilution Technique (Geetha et al., 2019).

RESULTS AND DISCUSSION

I. Sensory Evaluation of Cookies

Sensory evaluation of colored cookies were done and the following results were interpreted. Table 1 represents the overall average mean and SD of the parameters.

Table 1: Overall average mean and SD of organoleptic the parameters

Vegetables	Mean ± SD of sensory score					
	Color	Taste	Flavour	Texture	Appearance	Overall acceptability
Carrot	**4.95±0.78**	**4.52±0.66**	**4.47±0.64**	**4.43±0.62**	**4.30±0.61**	**4.53±0.66**
Beetroot	4.21±0.55	4.20±0.54	4.13±0.54	4.10±0.55	4.20±0.59	4.17±0.55
Mint	3.96±0.51	3.96±0.51	3.65±0.50	4.09±0.54	3.90±0.57	3.91±0.53
Palak	4.09±0.54	4.08±0.54	4.02±0.52	4.01±0.54	4.15±0.57	4.09±0.54

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With regard to the overall acceptability of the coloured cookies, the carrot extract incorporated cookies had the highest score of 4.53±0.66 followed by the beetroot, palak and mint extracts incorporated cookies with scores of 4.17±0.55, 4.09±0.54 and 3.91±0.55 respectively.

Table 2 gives the overall average mean and standard deviation of overall acceptability

Table 2: Overall acceptability of vegetable colours

Vegetable	Mean	Standard error
Carrot	**4.317**	**0.6234**
Beetroot	4.206	0.5654
Mint	4.000	0.5432
Palak	4.072	0.5712

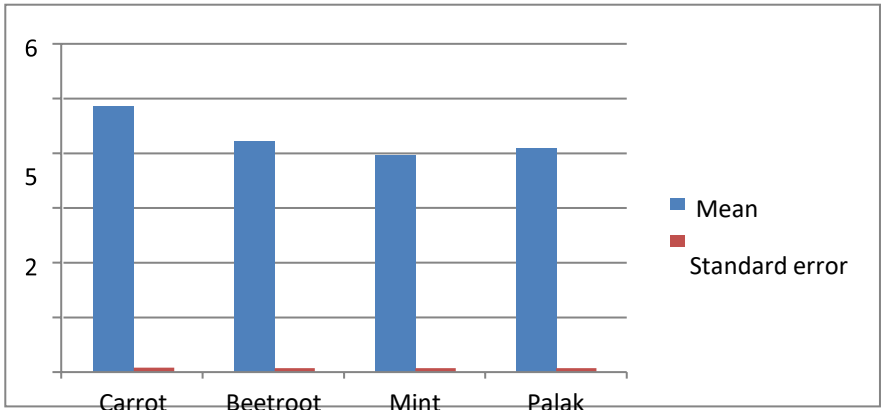

Fig 4: overall average mean and SD for overall acceptability

Among the four selected vegetables, according to hedonic scale which includes colour, taste, texture, flavour, appearance, overall acceptability carrot is highly preferred compared to other vegetables.

The mean and standard deviation of varied concentrations of carrot cookies were interpreted in the following table. Among the six variation , it was found that the sensory evaluation based on the five point hedonic scale indicated that the carrot D2 (20ML) incorporated into cookies were highly preferred.

A similar result was reported by Sharma and Sharma (2020), where cookies prepared with 15 per cent carrot juice concentrate were adjudged best by the panelists in terms of sensory score.

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According to the study conducted by Ingle *et al*., (2017), the sensory evaluation of cookies concluded that the cookies prepared with addition of 10% beetroot powder were more acceptable as compared to others.

Galla *et al*.,2016 observed that based on the sensory studies of biscuits it was shown that 5% supplementation of spinach powder was more acceptable. A study by Sirisha *et al*.,2019 demonstrated that spinach incorporation at 20% level in foxtail millet based masala biscuits could be employed as a source of micronutrients and antioxidants.

II. Nutritional analysis of natural colour-incorporated cookies

A. Moisture and protein

Among the four selected vegetables, according to hedonic scale which includes colour, taste, texture, flavour, appearance, overall acceptability carrot is highly preferred compared to other vegetables.

The moisture content and protein content of natural colour incorporated cookies with different concentrations (15,20 and 25 ml). Table 3 represents the moisture and protein content of the cookies.

Table 3 : Moisture % and Protein content

		Moisture %	Protein(g)
Control		**0.02**	**0.80**
Carrot	D1	0.04	1.078
	D2	0.06	3
	D3	0.08	3.4
Beetroot	D1	0.05	1.78
	D2	0.07	1.80
	D3	0.09	2.1
Mint	D1	0.05	3.2
	D2	0.08	3.4
	D3	0.20	3.5
Palak	D1	0.43	3
	D2	0.63	3.2
	D3	0.93	3.5

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The control cookies have a moisture and protein content of 0.02% and 0.80g respectively.

On comparison, 25ml of the mint extract incorporated cookies and 25ml of palak extract incorporated cookies had high protein content of 3.5g; and 25ml of palak extract incorporated cookies had the highest moisture content of 0.93%.

By performing the CRD test, it was shown that there is a significant difference ($p<0.05$) between the control and the natural vegetable colour incorporated cookies in terms of moisture and protein content.

Kumar & Kumar. (2011) reported that moisture content of cookies increases with increasing carrot extract level, which may however result in storage life. It was found that protein content was high in cookies made using mint extract. Sahni and Shere (2016) stated that the protein content of the cookies increased with the increase in beetroot pomace powder in the cookies. Ingle *et al*.,2017 observed that the protein content of the cookies incorporated with beetroot powder was increased from 7.39 to 9.12 %.

B. VITAMIN A

The vitamin A analysis was done only with the best variation of 20ml of the natural colour incorporated cookies. In order to observe the difference in vitamin A content among the vegetables, Vitamin A analysis was carried out. Table 4 represents the Vitamin A content of the cookies.

Table 4 : Vitamin A content of natural colour incorporated cookies

Extracted Natural colour (vegetables)incorporated cookies	**Vitamin A (IU)**
Carrot cookies	3341
Beetroot cookies	6.6
Mint cookies	3.80
Palak cookies	1875.40

From the above table 5, it was observed that Vitamin A content of Carrot Cookies were found to be the highest of 3341 IU and the lowest Vitamin A was observed with Mint cookies of 3.80 IU respectively, when compared to the other cookies c.FAT

Table 5 represents the fat content of the cookies.

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Table 5 : Fat content of natural colour incorporated cookies

Extracted Natural colour (vegetables)incorporated cookies	Fat %
Carrot	19.04
Beetroot	18.32
Mint	18.30
Palak	18.34

From the results obtained, it was observed that fat content of Carrot Cookies were found to be the highest with 19.04% and the lowest fat content was observed with Mint cookies with 18.30 respectively, when compared to the other cookies.

Ukeyima *et al*.,2019 observed that protein content of the cookies incorporated with carrot powder increased from fat content ranged from 8.89 – 15.85. According to the research conducted by Hossain *et al*.,2021, the fat content of the mint leaves powder enhanced cookies is 30.2%.

III. SHELF LIFE- MICROBIAL COUNT OF NATURAL COLOR INCORPORATED COOKIES

The shelf-life study was assessed by the pour plate method at 0, 15, 30 and 45th days. The microbial count is given in c.f.u/gram.

Table 6 represents the Total Plate count of the cookies.

Table 6 : Total plate Count of the cookies

		0 days	15th day	30th day	45th day
Carrot	**D1**	3×10^4	3×10^4	4×10^4	5×10^4
	D2	4×10^4	6×10^4	7×10^4	8×10^4
	D3	2×10^4	3×10^4	3×10^4	4×10^4
Beetroot	**D1**	3×10^4	4×10^4	6×10^4	7×10^4
	D2	1×10^4	1×10^4	1×10^4	2×10^4
	D3	2×10^4	2×10^4	3×10^4	4×10^4
Mint	**D1**	3×10^4	4×10^4	6×10^4	7×10^4
	D2	1×10^4	1×10^4	1×10^4	2×10^4
	D3	2×10^4	2×10^4	3×10^4	4×10^4
Palak	**D1**	3×10^4	4×10^4	6×10^4	7×10^4

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D2	1×10^4	1×10^4	1×10^4	2×10^4
D3	2×10^4	2×10^4	3×10^4	4×10^4

*D1 – 15ml of the vegetable extract

*D2 – 20ml of the vegetable extract

*D3 – 25ml of the vegetable extract

The microbial count during the course of storage period slowly increased. The microbial analysis of the coloured cookies were evaluated at day 0, day 15, day 30 and day 45. From the analysis it is evident that the total plate count in the fresh cookies (0th day) with 15ml of the carrot extract had increased from 3×10^4 cfu/g to 5×10^4 cfu/g on 45th day; and from 4×10^4 cfu/g to 8×10^4 cfu/g with 20 ml dose ; and from 2×10^4 cfu/g to 4×10^4 cfu/g with 25ml dose. Based on the overall results of microbial analysis, 20ml of the carrot color incorporated cookies had the highest total plate count of 8×10^4 cfu/g on the 45th day and the least plate count of 2×10^4 cfu/g was observed in 20 ml of the palak, mint and beetroot incorporated cookies on the 45th day. There is not much research studies carried out on the microbial analysis of colored vegetable cookies.

According to the WHO standards (1994) & Gill et al., (2021) stated that the maximum permissible limit in baked products like cake, biscuit, bread, cookies for Total Plate count was **2×10^5 cfu/g,**

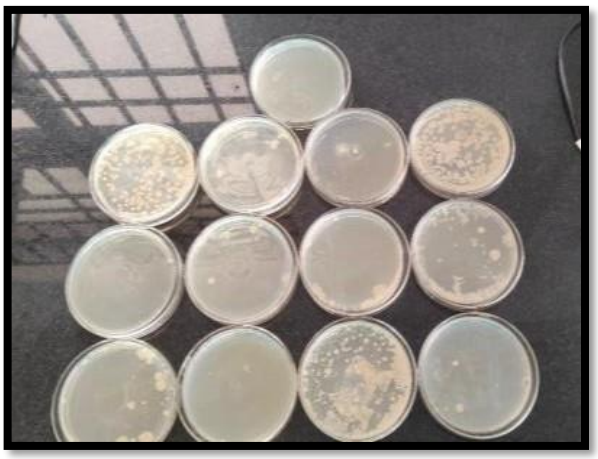

Fig 5: Results obtained by Total Plate Count of the cookies

CONCLUSION

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The four naturally extracted colors were incorporated into the cookies after the standardization of the liquid extract. According to the sensory evaluation, the most preferred natural food color was carrot with 20ml/100g of dough. These cookies had good nutritional value like protein, vitamin A and fat.. Based on the overall results of microbial analysis, 20ml of the carrot color incorporated cookies had the highest total plate count of 8 x 10^4 cfu/g on the 45th day and the least plate count of 2 x 10^4 cfu/g was observed in 20 ml of the palak, mint and beetroot incorporated cookies on the 45th day.

In conclusion, the incorporation of naturally extracted colors from vegetables in cookies offers a range of benefits to both food manufacturers and consumers. The use of naturally extracted colors from vegetables aligns with the growing consumer demand for clean, natural, and healthier food options. The incorporation of vegetable-based colors allows for clean labeling, promoting transparency and consumer trust.

References:

Dey, S., & Nagababu, B. H. (2022). Applications of food color and bio-preservatives in the food and its effect on the human health. *Food Chemistry Advances*, *1*, 100019. https://doi.org/10.1016/j.focha.2022.100019

Galla, N. R., Pamidighantam, P. R., Karakala, B., Gurusiddaiah, M. R., & Akula, S. (2017). Nutritional, textural and sensory quality of biscuits supplemented with spinach (Spinacia oleracea L.). *International Journal of Gastronomy and Food Science*, *7*, 20-26. https://doi.org/10.1016/j.ijgfs.2016.12.003

Geetha K., Yankanchi G. M., & Hiremath N. (2019). Microbial Quality and Storage Stability of Millet Based High Fiber Food Mix. *International Journal of Current Microbiology and Applied Sciences.* 8(7): 53 https://doi.org/10.20546/ijcmas.2019.807.007

Gill, A, John, A, Iqbal, N, Faridi TA and Noor S (2020), Assessment of Biochemical profile among patients of microbiological quality assessment of bakery products available in Lahore, Pakistan, *Journal of Nutritional & Food Sciences*, 1(1), 24-29.

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 12, Iss 4, 2023

Ingle, M., Ingle, M. P., Thorat, S. S., Nimbalkar, C. A., & Nawkar, R. R. (2017). Nutritional evaluation of cookies enriched with beetroot (Beta vulgaris L.) powder. *International Journal of Current Microbiology and Applied Sciences*, *6*(3), 1888-1896. https://doi.org/10.20546/ijcmas.2017.603.214

Ingle, M., Thorat, S. S., Kotecha, P. M., & Nimbalkar, C. A. (2017). Nutritional assessment of beetroot (Beta vulgaris L.) powder cookies. *Asian Journal of Dairy & Food* Research, 36(3). doi10.18805/ajdfr.v36i03.8963

Kumar, N., & Kumar, K. (2011). Development of carrot pomace and wheat flour based cookies. Journal of Pure and Applied Science and Technology, 1(1), 5-11. ISSN : 2249-9970

Official method of Analysis of AOAC International (1990).AOAC International , Gaithersburg,MD, USA , 1(15) Edition.

Sahni, P., & Shere, D. M. (2016). Physico-chemical and sensory characteristics of beet root pomace powder incorporated fibre rich cookies. International Journal of Food and Fermentation Technology, 6(2), 309-315. DOI: 10.5958/2277-9396.2016.00055.6

Sharma, S., & Sharma, K. D. (2020). Development of Carrot Juice Concentrate Enriched Functional Cookies. *Int. J. Curr. Microbiol. App. Sci*, *9*(12), 3129-3135. https://doi.org/10.20546/ijcmas.2020.912.372

Sirisha, K. S., Hymavathi, T. V., & Shreeja, K. (2019). Development of spinach (Spinacia oleracea L.) incorporated foxtail millet (Setaria Italica) based biscuits. *Journal of Pharmacognosy and Phytochemistry*, *8*(5), 358-361. P-ISSN: 2349–8528

Slurrp Editorial, 2023. Red Alert: The Risks Of Red Dye 40 In Food. https://www.slurrp.com/article/red-alert-the-risks-of-red-dye-40-in-food-1674321163692

Ukeyima, M. T., Dendegh, T. A., & Okeke, P. C. (2019). Effect of carrot powder addition on the quality attributes of cookies produced from wheat and soy flour blends. *Asian Food Science Journal*, *10*(3), 1-13. DOI: 10.9734/AFSJ/2019/v10i330039

WHO, 1994, Guideline value for food and drinking water, *World Health Organization*, Geneva , 3-4.