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Article

Prevalence and impact of dye adulteration in toffee consumption: A case study on mildly acute or acute toxicity affecting the population in misbranded toffee and candy consumption; an occupational health study report and branding strategies in marketing new products

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Abstract: Advancements in toxicological research have led to the development of several innovative methods for assessing the safety and potential risks of chemicals and toxic substances. This study investigates the prevalence and health implications of dye adulterants in toffees in excess amount from various brands distributed during a corporate year-end evaluation in Navi Mumbai, New Bombay 2015. The research employs random and stratified sampling methodologies to ensure a comprehensive analysis of the market. Laboratory tests reveals that dye X is present in 100% of samples from each brand, contradicting the natural flavour labels. Descriptive statistics indicate variations in dye concentration among brands, and ANOVA results demonstrate statistically significant differences in mean dye concentrations. Despite the presence of dye X across all brands, the chi-square test does not show a significant association between dye presence and brand at a 0.05 significance level. Employees reported adverse health effects, including dysuria, fatigue, and cardiovascular disturbances, after consuming the toffees, and tea. These findings highlight the need for stringent regulatory measures and consumer awareness to ensure food safety and mitigate health risks associated with food dye adulteration. The primary focus of this research study was to advance new methodologies for health monitoring and toxicology analysis that minimise large-scale disruptions. It aimed to foster innovation in medical science and establish new, documented methods for healthcare practitioners and professionals. These methods are designed to comprehensively analyse and document toxic events and systematically record data, enhancing the ability to manage and understand toxicological risks in a more controlled and efficient manner.

Keywords: ANOVA; cardiovascular health; chi-square test; descriptive analysis; dye; adulteration; food safety; health effects; occupational health; stratified sampling; toffees or sugar candies

1. Background

The consumption of artificially coloured food products, such as toffees, has raised significant health concerns, particularly regarding the potential adverse effects of synthetic dyes. Recent reports from employees in a corporate setting indicated a range of mild health issues, including dysuria, fatigue, and cardiovascular disturbances, following the consumption of various toffees. The investigation aimed to assess the safety of these products, particularly focusing on darker dyes found in toffees from unrecognised and potentially unsafe brands.

In this cohort study, consumption patterns were analysed among consumers aged 21 to 25, noting that individuals typically consumed between 1 and 7 toffees of different colours and flavours in a single incident reported. verbally.

The ordinary frequency of consumption suggests that even occasional intake could pose risks if the products contain harmful additives. Understanding the acute toxic effects associated with these dyes is critical, as they may contribute to immediate health issues, particularly among younger adults who are frequent consumers of such products. This research seeks to illuminate the risks associated with the consumption of non-regulated food colours, emphasising the need for heightened awareness and regulatory scrutiny in the food industry, and distribution of non-regulated food products in the markets.

Documented short note: Regarding the employees' reported adverse health effects, it was noted that the quantity consumed varied, typically ranging from 1 to 7 toffees of different colours and flavours with an ordinary frequency of consumption. The incident occurred only once, and the participants were aged between 21 and 25. Focused on the acute toxic effects associated with darker dyes in toffees from unrecognised and potentially unsafe brands.

2. Introduction

The Rapid Alert System for Food and Feed (RASFF) is recognised as a reporting system for food safety issues within the European Union (EU). Established in 1979, RASFF facilitates the flow of information to enable quick responses when public health risks are identified in the food chain. Numerous research articles have utilised the RASFF database to report on health risk incidents in various areas, such as the global food supply chain, risk analysis of biogenic amines in food, nut products, food contaminated with Listeria, and herbs like oregano. Although condiments used in spices are significant food ingredients, but they have received relatively little attention [1–5].

Monosodium Glutamate (MSG) is a widely used additive in the food industry, found in a vast array of ingredients and processed foods globally. Its popularity has increased significantly over time, making it a staple in many grocery stores and markets. MSG is known for providing foods with a distinct flavour called umami, a Japanese term that translates to "savoury" in English. While MSG is valued for its ability to enhance taste, it has been linked to several negative health effects. These include connections to obesity, metabolic issues, Restaurant Syndrome, neurotoxicity, and adverse impacts on reproductive health, damages and slow or retarded neuro health [6]. The study explored urban populations' awareness and perceptions regarding Monosodium Glutamate (MSG) and its potential impacts on well-being. MSG, a commonly used food additive, affects flavour profiles and surface qualities, raising concerns about its health implications. The research involved developing, interpreting, and adjusting a survey, which was vetted by nutrition experts. Data was gathered from 13 September to 31 October 2023, with a sample size of 420 participants. Statistical analysis revealed significant correlations with socioeconomic factors. Key findings include awareness of MSG's health effects, links to various health conditions, and strong support for its removal from food products [7].

The risks associated with food ingredient fraud and economically motivated adulteration are increasing. However, there is currently no comprehensive database detailing problematic ingredients and the methods used to detect them. The 8th edition of the Food Chemicals Codex by the US Pharmacopeial Convention includes 1305 entries, with 1000 of them containing analytical methods that serve as references for food toxicology analysis related to food-induced toxicants that can harm people's health [8]. Food adulteration refers to the intentional modification of food quality, typically for financial or commercial gain. This process involves adding ingredients to alter the food's colour, appearance, taste, weight, volume, shelf life, and other characteristics. Commonly adulterated items include olive oil, milk, honey, and saffron [8].

Concerns about the quality and authenticity of food products have increased recently, making food adulteration a common issue. Certain case study examines the adulteration of blueberry juice and uncovers deceptive practices that may pose health risks to consumers purchasing such juices from the market. The adulteration process includes replacing blueberry extract with an artificial colourant, which can cause stomach discomfort if consumed in large amounts. This colourant is cleverly mixed with banana peel powder to create the pulp. The deceptive mixture is further enhanced by the addition of basil seeds, saccharin (a sugar substitute), and artificial flavours and essences [9].

Pesticide residues and unauthorised dyes as adulteration markers in chilli pepper and tomato were subjected to evaluate the contamination in processed chilli peppers and tomatoes, a report spanning four decades since the establishment of the Rapid Alert System for Food and Feed (RASFF) was retrieved and analysed. Out of the 887 notification reports evaluated for eligibility, 446 were related to contamination of chilli peppers and tomatoes. The study identified India as the country of origin with the highest number of cases related to chilli pepper contamination. Meanwhile, Italy and Turkey had the most cases of exporting adulterated tomatoes to other countries, according to the RASFF report. Unauthorised dyes such as: Sudan I, III, IV, orange II, rhodamine B, and para red were detected in the supply chain of either chilli peppers or tomatoes. Nearly, all unauthorised dyes found in this study exceeded the detection limit range (0.5 to 1 mg/kg) for Sudan dye and similar dyes using analytical methods established by the European Union. Pesticides that have not been approved by the European Union (EU) were also found. These include: acetamiprid, chlorothalonil, chlorpyrifos, dimethoate, methomyl, monocrotophos, omethoate, oxamyl, and thiophanate methyl. The findings indicate the ongoing contamination of chilli peppers and tomatoes with hazardous dyes and pesticide residues, despite the prohibition of certain chemicals in the food chain [10].

Spices are primarily used in cooking, especially in ready-to-eat foods, and serve as flavouring agents for consumers. Over the years, the safety of food condiments used as spices in the food industry has received little attention, even though potential contamination of these spices is crucial for food safety and quality. Most contamination studies have focused on microbes and secondary metabolites like mycotoxins. However, other contaminants, particularly chemical contaminants like pesticide residues, are especially important for the Capsicum and Solanum families, which include tomatoes and chili peppers. Although spices are used in small quantities

in food preparation, they can contribute to overall contamination levels in the final food product if they are contaminated [11]. Unauthorised dyes, including orange II, Sudan dyes, rhodamine B, fast garnet, oil orange, and para red, have been detected in processed chilli peppers and tomatoes. Also, high residual levels of chemical compounds such as carbendazim (5.69 mg/kg) and bromide (84.9 mg/kg) were found in processed chilli peppers and tomatoes, respectively. Despite bans on certain dyes and pesticides, the contamination levels reported in studies are concerning. To address this issue, more rigorous and routine testing of products from various sources is needed. This would provide risk managers with reliable evidence to develop effective future monitoring programmes [10] (**Figure 1**).

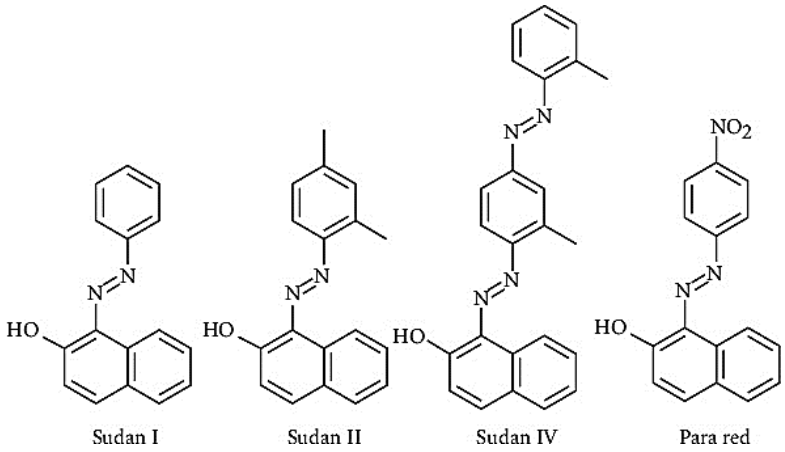


Figure 1. Structural formulas of some commonly studied azo dyes [12].

Many food manufacturers use dyes or colourants to conceal ageing, mask spoilage, and disguise inferior or spoiled food and processed products. The amount and type of dye used are irrelevant to the manufacturer, as long as their goal is achieved. Dyes such as: Sudan dyes (I, II, III, and IV), para red dye, metanil yellow, and orange II, among others, have been found in condiments. These dyes are likely used because they resemble the condiments or spices in question, as they may have similar physical or chemical properties. However, these dyes, frequently used by fraudsters, are typically not approved for use in food processing. One of the most significant contaminants of spices is pesticide residue from agricultural sources [10].

Other food adulterants: The Codex Alimentarius provides the official limits for pesticide residues, including those applicable to condiments used as spices [13].

Recent research indicates that some of the pesticides identified in this study pose significant risks to human health and the environment, particularly those from the organophosphate group (such as: malathion, chlorpyrifos, dimethoate, dichlorvos, cypermethrin, and ethion) and the organochlorine group (such as dicofol). The prevalence of pesticide residues reported is attributed to misuse, overuse, improper application of pesticides, the illegal use of unregistered or unauthorised pesticides, and inadequate conditions for harvesting or storage (including the waiting period after pesticide application) [14,15] (**Figure 2**).

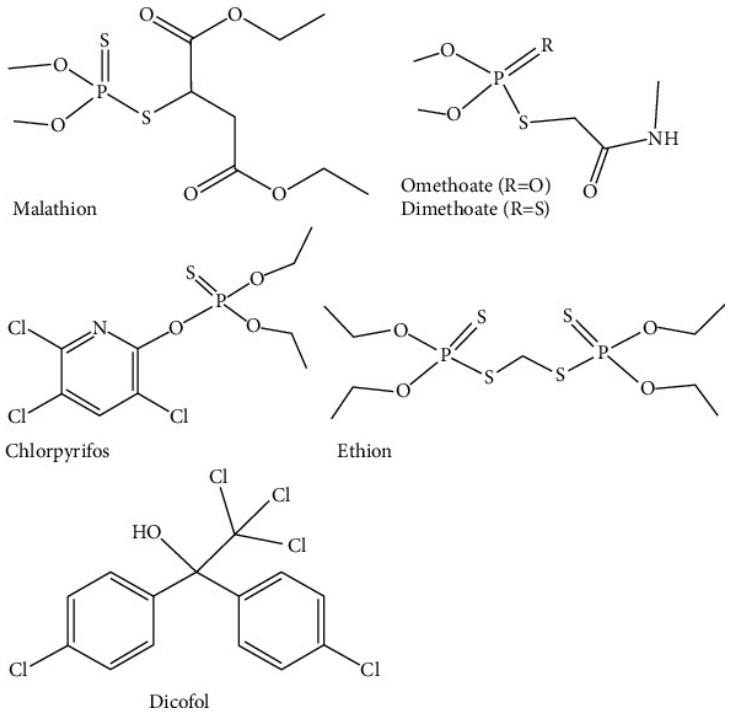


Figure 2. Active pesticide ingredients from the organophosphate and organochlorine groups found in processed chili peppers and tomatoes have been reported by the European Union's Rapid Alert System for Food and Feed (RASFF) [10].

3. Research methodology

3.1. Objective

The primary objective of this study is to determine the prevalence of certain dye adulterants in different brands of toffees available in the market.

To determine the prevalence of certain dye adulterants in different brands of toffees random and stratified sampling methodology was implemented to collect the data.

Case study: Obtained from occupational zone (Navi-Mumbai) or (New Bombay); 2015

In a corporate setting, employees typically enjoy toffees at workplace. Bags contain toffees of various colours, attractively packaged in clear wrappers with labels like: blueberry, saffron, pineapple, and strawberry are common. However, the toffees misbranding with absence of contains of the flavours indicated on the labels; instead, they were incorporated with dyes and flavours that are too dark and strong. After consuming the toffees, newer employees experienced issues such as: dysuria, fatigue, decreased work efficiency, low heart rate, and exhaustion. These incidents were reported, and the discussions were documented for further investigation.

Apart from some employees experiencing issues, others reported that consuming too many toffees caused a sore mouth and experiencing a pungent or irritative sensation in the oral cavity, gastrointestinal tract, and anorectal region.

They also felt discomfort and experienced dysuria.

3.2. Methodology

To achieve these objectives, the study utilises both random sampling and stratified sampling methodologies to collect representative data from the population of toffee brands consumers. This combination allows for a comprehensive understanding of the market while ensuring specific subgroups are adequately represented. A cohort study was conducted in a market setting to evaluate the scientific significance of these products through systematic analysis and assessment. The market offers a wide array of choices, and selection is guided by individual preferences and safety considerations. To enhance safety, adherence to scientific protocols and newer regulatory standards and measures are essential. In addition to toffees, various chutneys and sauces from numerous brands contain flavoring agents and colourants, some of which possess bioactive properties with potential health implications.

Sampling methodologies

Random sampling and stratified sampling, with sample number: as such sample size determination: the sample size is determined based on the desired confidence level (e.g., 95%) and margin of error (e.g., 5%). Statistical formulas for sample size calculation are used to ensure the results are statistically significant.

Laboratory testing:

The collected toffee samples were analysed using a well-established laboratory method designed to detect dye adulterants across the necessary spectrum and perform titration as needed.

Data recording: (**Table 1**).

The results of the laboratory tests were systematically documented, indicating which dyes were present in each toffee sample and their respective quantities.

Data cleaning and preparation:

From the obtained data:

Data validation: ensuring that all collected data is accurate and reliable and was checked for any inconsistencies or errors in the recorded information.

Handling missing data: addressing any missing values appropriately. This shall involve imputation techniques if the missing data is small or excluding incomplete records—with significant.

Normalisation (if necessary): normalise data for variations in sample sizes or concentrations to facilitate meaningful comparisons.

The descriptive analysis and comparative analysis were also done to measure:

Frequency distribution, measures of dispersion, comparative analysis: compare brands/batches and statistical tests.

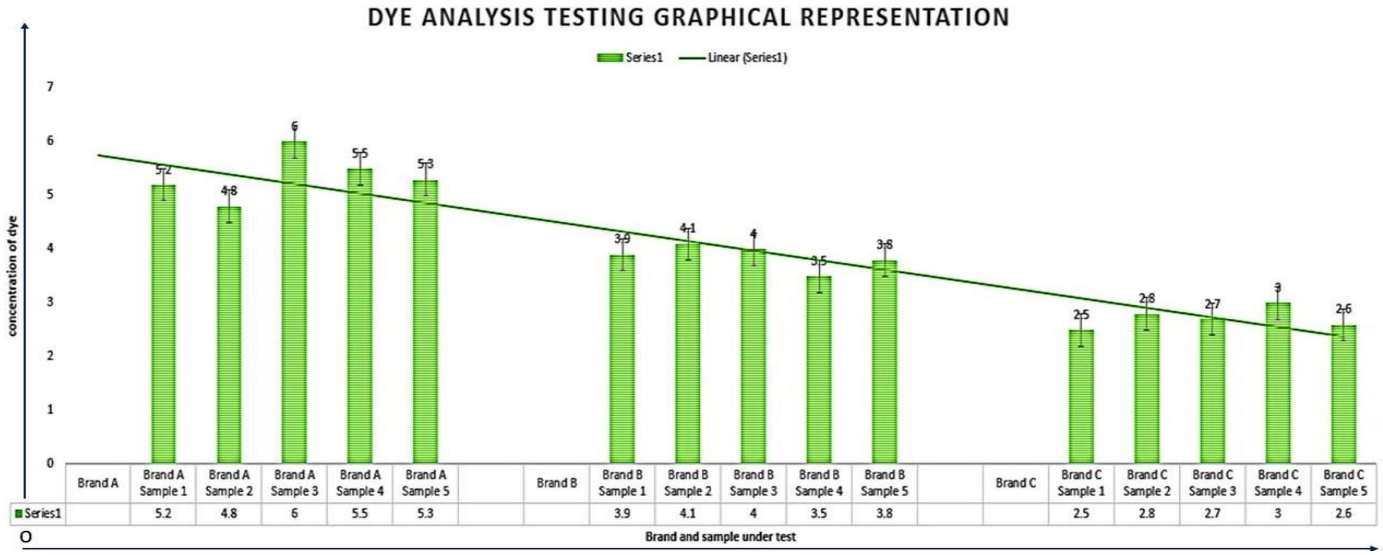
Inferential analysis as such: hypothesis testing, and confidence intervals were significantly measured [16] (**Figure 3–5**).

Figure 3. Random and stratified sample of toffee along with dry dye sugar melted dye.

Figure 4. Colour testing or the dye presence in the analytical sample.

Table 1. Collected data from the table.

Brand	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Brand A	5.2 mg	4.8 mg	6.0 mg	5.5 mg	5.3 mg
Brand B	3.9 mg	4.1 mg	4.0 mg	3.5 mg	3.8 mg
Brand C	2.5 mg	2.8 mg	2.7 mg	3.0 mg	2.6 mg



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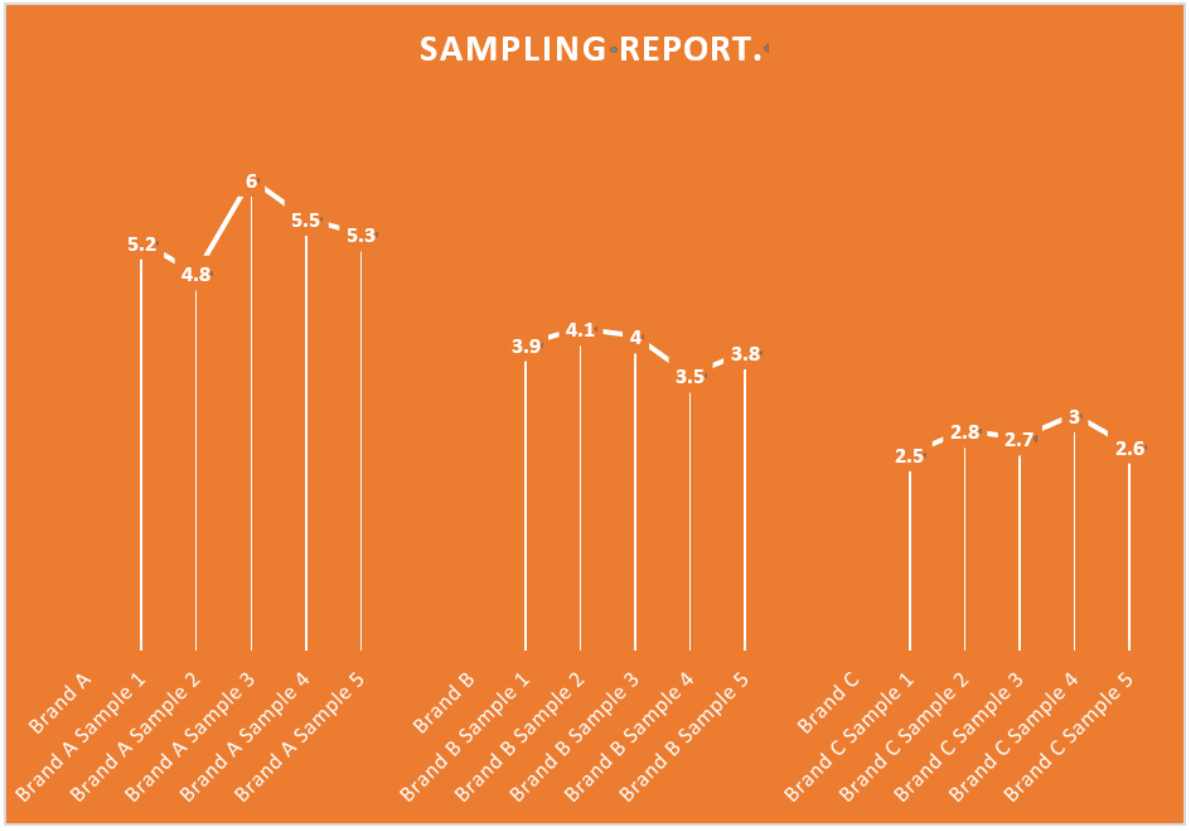


(b)

Figure 5. Graphical representation of analysis of toffee. **(a)** Dye analysis testing graphical representation; **(b)** sampling report.

4. Result

4.1. Data evaluation procedure

Descriptive analysis

Frequency distribution: the detection of x dye in each brand was evaluated and was detected at 100% for each brand (**Tables 2–4**, **Figures 6–8**).

Table 2. Measures of central tendency.

Brand	Brand A	Brand B	Brand C
Mean	5.36 mg	3.86 mg	2.72 mg
Median	5.3 mg	3.9 mg	2.7 mg
Mode	5.2 mg, 5.3 mg, 5.5 mg (all appear equally)	3.5 mg, 3.8 mg, 4.0 mg, 4.1 mg (all appear equally)	2.5 mg, 2.6 mg, 2.7 mg, 2.8 mg (all appear equally)

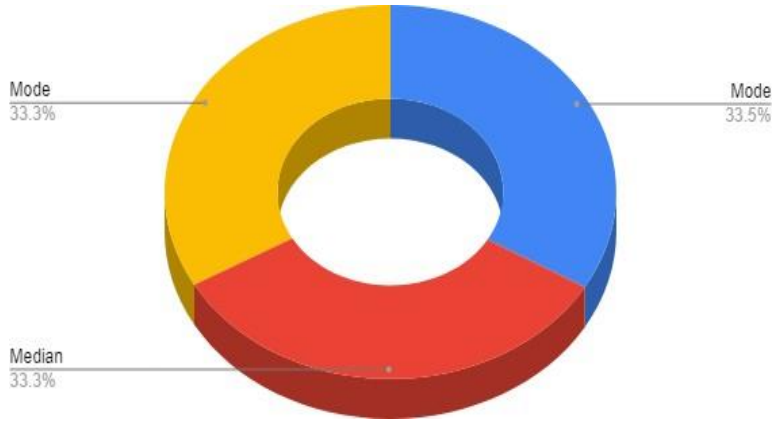


Figure 6. Measures of central tendency.

Table 3. Mode: measures of dispersion.

Brand	Brand A	Brand B	Brand C
Range	1.2 mg	0.6 mg	0.5 mg
Variance	0.193 mg²	0.053 mg²	0.037 mg²
Standard Deviation (SD)	0.439 mg	0.230 mg	0.192 mg

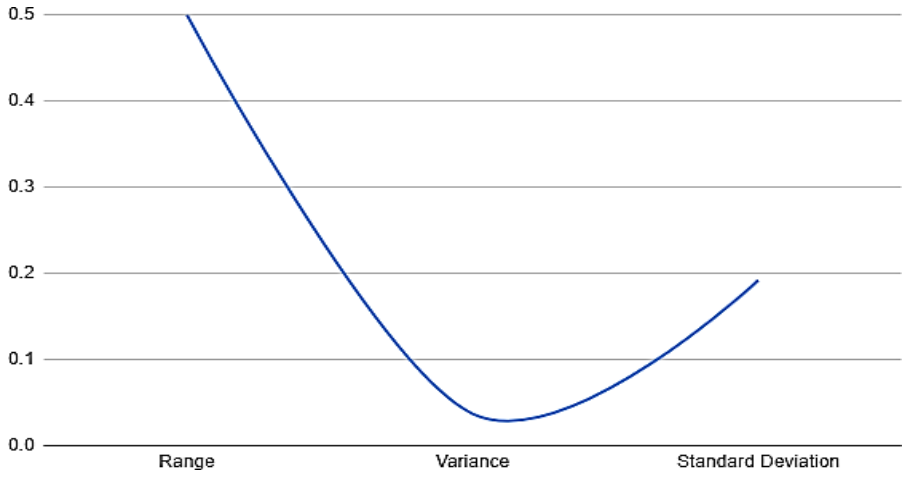


Figure 7. Mode: measures of dispersion.

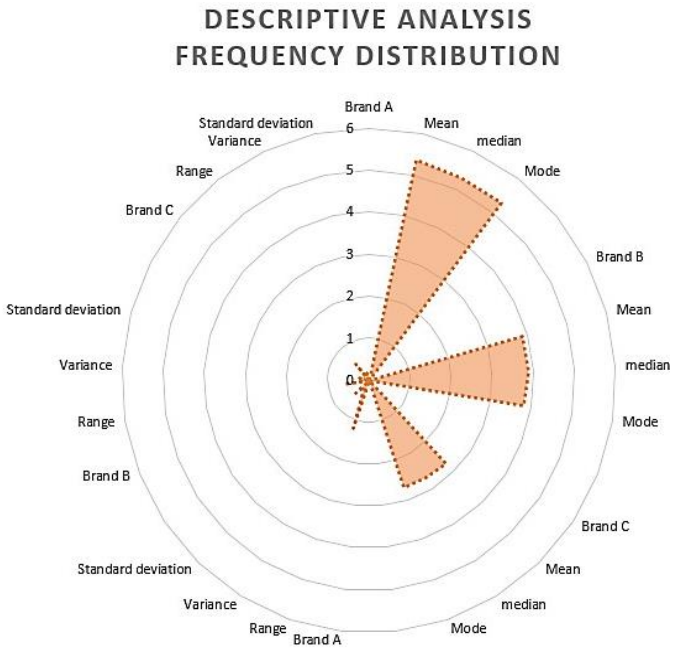


Figure 8. Descriptive analysis and frequency distribution study of the recorded data.

Table 4. Data (dye X concentrations in mg).

For Brand A:		**For Brand B:**		**For Brand C:**	
I.	Sample 1: 5.2 mg	I.	Sample 1: 3.9 mg	I.	Sample 1: 2.5 mg
II.	Sample 2: 4.8 mg	II.	Sample 2: 4.1 mg	II.	Sample 2: 2.8 mg
III.	Sample 3: 6.0 mg	III.	Sample 3: 4.0 mg	III.	Sample 3: 2.7 mg
IV.	Sample 4: 5.5 mg	IV.	Sample 4: 3.5 mg	IV.	Sample 4: 3.0 mg
V.	Sample 5: 5.3 mg	V.	Sample 5: 3.8 mg	V.	Sample 5: 2.6 mg

Calculation of ANOVA with reference to collected data sample and data recording:

For Brand A: Mean A = 5.36 mg, (**Table 5**)

For Brand B: Mean B = 3.86 mg, (**Table 5**)

For Brand C: Mean C = 2.72 mg. (**Table 5**)

Calculating the grand mean: Grand Mean: 3.33 mg.

Step 3: Calculate Sum of Squares (SS) for Between Groups (SSB) and Within Groups (SSW) (**Table 6**).

SSB (Sum of Squares Between Groups): Measures the variability between the means of different groups (brands).

$$SSB = \sum_{i=1}^{3} \eta i \, (Mi\text{-}GM)^2$$

Table 5. Sum of Squares Between Groups.

For Brand A:	**For Brand B:**	**For Brand C:**
SSB A = 20.55	SSB B = 1.40	SSB C = 1.85
	Total SSB =	23.80

$$SSW = \frac{3}{i=1}\frac{5}{j=1}\left(S_{ij} - M_i\right)$$

Table 6. Sum of Squares Within Groups.

For Brand A:	**For Brand B:**	**For Brand C:**
SSW A = 1.05	SSW B = 0.26	SSW C = 0.21
	Total SSW =	1.52

Degrees of freedom (*df*) calculation:

Between group ($df_{between}$) and within groups (df_{within}):

So, by counting the between group ($df_{between}$) and within groups (df_{within}); $df_{between}$ = 2 and df_{within} is 12.

Calculation the mean squares:

Mean square between ($MS\_{between}$):

$MS\_{between}$ = 23.80 ÷ 2

$MS\_{between}$ = 11.90

Mean square within (MS_{within}):

MS_{within} = 1.52 ÷ 12

MS_{within} = 0.1267

Calculating the *F*-statistic for an analysis of variance (ANOVA): F = **MS between**

MS within

From the calculation:

$MS\_{between}$ = 11.90 and MS_{within} = 0.1267

Substituting the value:

$F \approx 93.86$ and $F_{critical} = 3.89$

The *F*-statistic in summarisation likely suggest the significant difference in the mean dye concentration between the brands of toffees.

Thus, the conclusion includes: In comparison to the values obtained based on them, the null hypothesis is therefore rejected. Thus, there are statistically significant differences in the dye concentration within the brand and in between the brand of toffees. Thus, these implies significantly different mean dye concentration compared to the others.

A. Hypothesis testing:
   a. Null hypothesis (H_0): Dye X is not present in toffees.
   b. Alternative hypothesis (H_1): Dye X is present in toffees.

B. Inferential statistics:

The presence or absence of specific dyes in toffees: includes the artificial dye and the natural colourant dye; such as: saffron, blueberry, strawberry, and the beetroot colourant, than that of the metallic and chrome dyes as artificial colourants in on permitted order.

C. Statistical test:

Since dealing with categorical data (presence/absence), use of a chi-square test for independence to determine if there is a significant association between the presence of dye X and the toffee brands is significant at the stage to check it statistically.

Test statistic (chi-square):

Observed frequencies (O): Number of toffees with dye X and without dye X for each brand. (**Table 7**).

Expected frequencies (E): Expected distribution assuming no association between dye X and brands.

Table 7. Data of Dye X present or absent in brands.

X	Dye X present	Dye X absent
Brand A	25	15
Brand B	20	20
Brand C	30	10

Calculating the total number of observations (*N*) and the degrees of freedom (*df*):

N = Observed frequencies = 25 + 20 + 30 + 15 + 20 + 10 = 120 (**Table 8**).

df = (Number of rows − 1) × (Number of columns − 1) = (3 − 1) × (2 − 1) = 2

Thus, occupying the expected frequencies in the mind and assuming no association between dye X and the brands; it can be calculated on marginal totals, thus.

Table 8. Data on Dye X in brands and its total.

X	Dye X present	Dye X Absent	Row Total
Brand A	20.83	19.17	40
Brand B	20.83	19.17	40
Brand C	33.33	6.67	40
Column total	75	25	120

Calculating the chi-square statistics: Expected frequencies (E) [16].

The expected frequencies can be calculated using the formula:

$$E = \frac{Row\ Total\ \times Column\ Total}{Grand\ Total}$$

The calculated expected frequencies for each:

Brand A, dye X present:

$$E = \frac{(\mathbf{25}-\mathbf{20.83})\mathbf{2}}{\mathbf{20.83}} \approx 0.83$$

Brand A, dye X absent:

$$E = \frac{(\mathbf{15}-\mathbf{19.17})\mathbf{2}}{\mathbf{19.17}} \approx 0.90$$

Brand B, dye X present:

$$E = \frac{(\mathbf{20}-\mathbf{20.83})\mathbf{2}}{\mathbf{20.83}} \approx 0.033$$

Brand B, dye X absent:

$$E = \frac{(20-19.17)^2}{19.17} \approx 0.036$$

Brand C, dye X present:

$$E = \frac{(30-33.33)^2}{33.33} \approx 0.033$$

Brand C, dye X absent:

$$E = \frac{(10-6.67)^2}{6.67} \approx 1.66$$

Chi-square statistic: The chi-square statistic (χ^2) is calculated using the formula [17]:

$$\chi^2 = \sum \frac{(o-E)^2}{E}$$

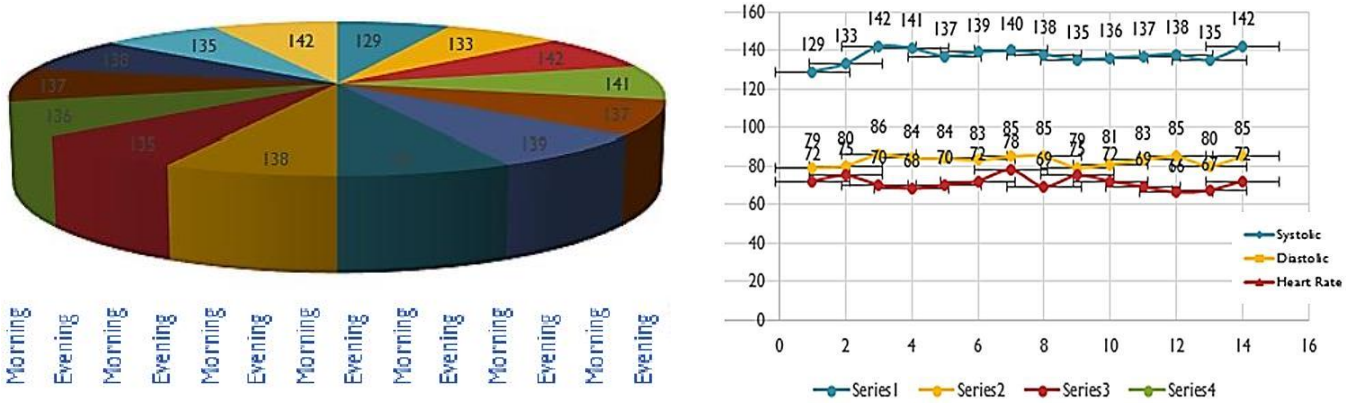
279 $\chi^2 \approx 3.80$

The calculated chi-square statistic for the given data is approximately 3.80.

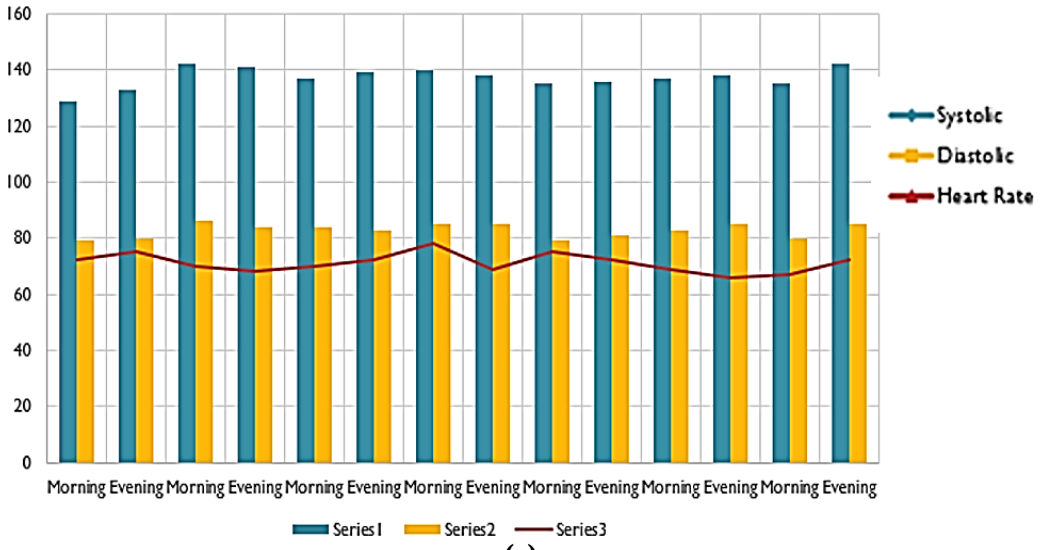
From the chi square distribution the significant value is 5.99 at the freedom of 2 degrees; and also 9.21 at the freedom of 2 degrees with each varying significance: α: 0.05, 0.01 respectively.

As such: $df = (3 - 1) \times (2 - 1) = 2$.

Cardiovascular monitoring of the people who consumed excessive toffee included following records: (**Figure 9**).



(a) **(b)**



(c)

Figure 9. Cardiovascular health record of the affected toffee consumers (via use of automatic tracking systems for health data recording and analysing). **(a)** Pie chart representation; **(b)** graphical representation; **(c)** bar graph representation.

5. Discussion

a. Calculated chi-square statistic: 3.80.
b. Critical value: 5.99 and 9.21.

Since the calculated chi-square statistic (3.80) is less than the critical value (5.99), and (9.21) it had failed to reject the null hypothesis at the 0.05 significance level. This suggests that there is not enough evidence to conclude a significant association between the brand and the presence of dye X.

The calculated value of the $\varkappa^2$ statistic represents approximately 3.80; this value represents the strength of the association between the presence of the dye $\varkappa^2$ and the different brands of toffees. To determine it statistically other than the chemical evaluation, this association compares the obtained chi square value to a critical value from the chi-square distribution table at a specified significance level (often alpha = 0.05 or alpha = 0.01).

Rejecting the null hypothesis means that there are statistically significant differences in mean dye concentrations between the brands of toffees. This implies that at least one brand has a significantly different mean dye concentration compared to the others. The alternative hypothesis is accepted finally to conclude the significance and therefore; the toffees produce the it significantly. The cardiovascular records of the affected through the report analysis results that, there is significant cardiovascular disturbances quite noticeable in the affected which results in the disturbed health balance and increased health disturbances; results in poor cardio health and poor over health performances. Few patients reported feeling of significant dis-motivation for more than a months' time and indicated potential health changes both systemically and mentally.

6. Conclusion

The study reveals widespread dye adulteration in toffees across multiple brands,

with all tested samples containing dye X despite misleading natural flavour labels. The ANOVA results indicate significant differences in dye concentrations between brands, although the chi-square test does not establish a significant association between dye presence and brand. The consumption of these toffees is linked to adverse health effects, including cardiovascular disturbances, highlighting the need for improved food safety regulations and consumer education. The findings emphasise the importance of monitoring and regulating food dye usage to protect public health and ensure the integrity of food products. Future research should focus on exploring alternative natural dyes and developing more effective regulatory frameworks to prevent food adulteration.

The titrimetric method is effective for analysing such dyes, and using U.V. spectroscopy and colorimetry are also significant and effective alternatives to titrimetric analysis. Colorimetric and UV-visible spectroscopic methods provide a simpler, easier, and less challenging alternative compared to manually analysing each sample by titration individually, which is time- consuming and requires large amounts of chemicals. In contrast, colorimetric and UV-visible spectrophotometric analyses are more efficient. Apart from this; an additional, ascending, descending, and radial paper chromatography can be used to provide easy and comparative results similar to titrimetric analysis methods. The methods developed through this research are highly effective for scientific findings, research, and analysis.

Moreover, and prominently in conclusion, this research study has made significant strides in advancing methodologies for health monitoring and toxicology analysis. By minimising large- scale disruptions, the developed approaches offer a more innovative and efficient way to address toxicological risks. The new, documented methods provide healthcare practitioners and professionals with robust tools for comprehensive analysis and documentation of toxic events. These advancements not only enhance the understanding and management of toxicological risks but also have practical applications in healthcare settings, Clinical Research Organisations (CROs), and research industries. Implementing these methodologies will improve data accuracy and reliability, ultimately contributing to more effective patient care and research outcomes.

Apart from this additionally, this research aids in the analysis of patient records and medical notes, enhancing the support provided to patients and enabling detailed examination of historical medical data and case histories. By integrating these records into systematic tools and internal company-based software, the methodologies contribute to precise clinical monitoring. This integration also supports healthcare research and facilitates comprehensive worst-case scenario analysis within health sciences and medical practices.

Further, this research also supports regulatory bodies and food and drug safety authorities by improving their ability to monitor and track such events. It aids in recording high-risk incidents and potential threats, enhancing future oversight and enabling advancements in medicinal knowledge. The DL_{50} (Dosis Letalis 50) values could be estimated and stated as: The DL_{50} (lethal dose 50) values for food colourants can vary significantly depending on the specific dye or colouring agent and the organism being tested (e.g., rodents, fish). Most food colours are considered safe for consumption at regulated levels, but specific toxicity data may not always be readily

available due to their approved usage.

For example, some common food dyes like tartrazine or Red 40 have been studied for their safety profiles rather than specific DL_{50} values, as they are used in very low concentrations in food. Regulatory bodies such as the FDA and EFSA set acceptable daily intake (ADI) levels based on extensive toxicological studies.

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Data collection: The data were gathered through verbal interactions, with information recorded and maintained for the study. Also, samples of toffees were analysed, and branded records were evaluated to identify the top market brands. Study of negligible brands or unrecognised brands provides an extra knowledge on marketing strategies.

Statistical data analysis: The comprehensive dataset was meticulously analysed, organised, and tabulated into a statistical format to facilitate precise calculations and result finalisation. Each statistical result underwent double check with rigorous verification and cross-checking, manually with the expertise of Dr. Prof. Sarika Shivaji Malode, to ensure the utmost accuracy and reliability, thereby reinforcing the validity of the findings.

Conflict of interest: The author declares no conflict of interest.

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