

Comparative analysis of nutritional content in common chocolate brands in India

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Highlights

This study, the first of its kind in India, compared nutrient values of popular chocolate brands using data from product labels and official online sources.

A negative correlation was found between sugar and fat/energy, while a positive correlation was observed between fat and energy.

The study highlights the importance of reviewing chocolate ingredients to make informed choices based on individual nutritional needs.

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Abstract

Aim: Chocolate is widely consumed, especially by children. While moderate intake may have benefits, excessive consumption is linked to dental caries. This study aimed to assess and compare total sugar, fat, and energy content in various chocolate confectioneries, evaluate correlations among these components, and examine consistency between product packaging and manufacturer-reported values. **Methods:** A cross-sectional analysis was conducted on a randomized sample of five chocolate types: dark, white, milk chocolate, toffees, and coated wafers. Products were selected from major retailers based on inclusion criteria requiring clear nutritional labeling and brand familiarity. In total, 56 products were analyzed. Nutritional values (per 100 g) for sugar, fat, and energy were collected from packaging and verified with data from official manufacturer websites. Descriptive statistics summarized nutrient content by category. Chi-square tests evaluated differences among chocolate types. Pearson correlation assessed relationships between sugar, fat, and energy content. Statistical analysis was performed using SPSS (version X), with significance set at $p < 0.05$. Results: Mean sugar content was 47.94 ± 9.68 g, highest in toffees (58.98 g), lowest in coated wafers (37.10 g). Mean fat was 29.06 ± 8.39 g, highest in milk chocolate (31.24 g), lowest in toffees (18.60 g). Energy content was highest in milk chocolate (530.33 Kcal) and lowest in coated wafers (453.00 Kcal). Significant differences were found in sugar ($p < 0.001$), fat, and energy content ($p = 0.027$). Sugar was negatively correlated with fat (-0.603) and energy (-0.259), while fat and energy were positively correlated (0.865). **Conclusions:** Parents and children should be informed about the nutritional content of chocolates. Excessive intake may contribute to caries and systemic health issues. Reading labels and making informed choices is essential for healthier consumption.

Keywords: Chocolate; Energy; Fat; Sugars

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INTRODUCTION

Approximately 60% of an individual's health and quality of life are correlated with lifestyle factors. People are increasingly inclined towards sedentary and unhealthy lifestyles, characterized by harmful habits such as poor dietary choices, tobacco and alcohol consumption, drug abuse, and inadequate hygiene practices, making them more susceptible to various health issues.¹ An unhealthy diet contributes to the rising prevalence of chronic diseases, including diabetes, cardiovascular disease, obesity, metabolic disorders, mental health disturbances, and dental caries.²

There is a strong relationship between sugar consumption and dental caries.³ Individuals consuming high amounts of sugar exhibit a 28% increase in DMFT scores. Dental caries prevalence among children aged 6 to 18 years is 20% higher in those with high sugar intake and 60% higher in children who frequently snack between meals.⁴ Cohort studies conducted globally have reported a positive association between increased sugar intake and weight gain.⁵ Sugar is considered a common risk factor for dental caries, obesity, and other metabolic disorders.^{6 7} To mitigate the harmful effects of sugar, the World Health Organization strongly recommends reducing sugar intake to less than 10% of total caloric intake.⁸ According to the Indian Council of Medical Research (ICMR), adults should not consume more than 30 g of free sugar per day. For children aged 7–10 years, sugar consumption should not exceed 24 g per day, while for those aged 4–6 years, it should be limited to 19 g per day to reduce the risk and prevalence of chronic diseases, obesity, and dental caries. High-carbohydrate (sugar) diets also induce fatty acid production in the liver due to the activation of the key regulatory transcription factor XBP1, leading to increased fat deposits in the body.⁹

Dietary guidelines from the World Health Organization and the Dietary Reference Intakes

recommend that total fat intake should range between 20% and 35% of total caloric intake.¹⁰ Exceeding this recommended limit leads to unhealthy weight gain and increases the risk of cardiovascular diseases.¹¹ The average daily energy allowance is 2300 kcal for men of reference size (77 kg) and 1900 kcal for women. Consuming energy beyond these recommended values, combined with low energy expenditure, contributes to obesity and various metabolic disorders.¹² Increased chocolate consumption has been a significant contributor to high sugar exposure. In 2022, global chocolate consumption varied from 0.2 kg per person per year in China to 11.8 kg in Switzerland. India ranked second lowest, with an annual per capita chocolate consumption of 1 kg.¹³

Carbohydrates are the primary source of sugars derived from both natural and processed foods. However, homemade sweets, packaged and processed foods, and chocolate confectioneries—such as chocolate spreads, syrups, and bars—constitute the major sources of added sugar intake. The market is saturated with various brands and types of chocolates, with some, such as dark chocolates, claiming health benefits for cardiac and overall systemic health.¹⁴ Despite these claims, there is a lack of scientific data on the sugar, fat, and energy content of different Indian chocolates, information that is essential for the general population to make informed dietary choices. This gap provided the impetus for a detailed assessment of the total sugar, fat, and energy content in commonly available chocolates in the Indian market.

This study aimed to: a) assess and compare the total sugar, total fat, and energy content of different brands of chocolate confectioneries, b) evaluate the relationship between total sugar, total fat, and energy content among various chocolate confectioneries, and c) compare the nutrient values displayed on official websites with those provided on product packaging.

METHODS

Ethical approval

The study protocol was reviewed and approved by the Institutional Ethics and Research Committee. After detailed evaluation and discussion regarding the study's objectives, methodology, and potential implications, ethical clearance was granted under the reference number G-131/IECDYPDS/2023. This approval ensured that the study adhered to ethical standards and guidelines for research involving data collection and analysis.

Data collection

Eligibility criteria

Chocolate confectioneries were defined as semi-solid or solid food products primarily composed of chocolate or cocoa, with or without the inclusion of fruits or nuts, including those coated, covered, or incorporated into sugar-based confectionery. Only recently manufactured and packaged products with clear nutritional labeling specifying total sugar, total fat, and total energy content were eligible for inclusion. Unpackaged, expired products or those lacking nutritional labeling were excluded.

Chocolates were selected based on widespread consumer usage and brand popularity, prioritizing products from Cadbury, Nestlé, Hershey's, Galaxy, and Amul over other brands and locally produced items.

A hierarchical classification framework was developed to systematically categorize confectionery items based on predefined inclusion and exclusion criteria. The included chocolate-based products were classified into "Milk Chocolate," "Dark Chocolate," "White Chocolate," "Coated Wafers," and "Toffees," facilitating a comprehensive and standardized analysis. This classification ensured precise differentiation among subtypes, improving data reliability and comparative assessments.

Conversely, the excluded confectionery items included "Sugar Boiled," "Flour," "Milk," and "Others," minimizing potential confounding variables and enhancing dataset specificity.

A total of 56 chocolates that met the eligibility criteria were randomly selected, consisting of 15 dark chocolates, 29 milk chocolates, 3 white chocolates, 6 coated wafers, and 8 toffees. The study examined three key nutritional variables: Total Sugar (per 100g), Total Fat (per 100g), and Energy Kcal (per 100g) (Table 1).

Evaluation of nutritional content

The nutrient values of the selected chocolates were provided per 100 g on the product packaging. However, food consumption is typically measured by standard serving sizes. According to the FDA's Reference Amounts Customarily Consumed (RACCs), one serving is defined as 30 g.¹⁹ In this study, the total sugar, fat, and energy content were evaluated by converting the values from 100 g to a 30 g serving size.

Statistical analysis

The assessment of total sugar (per 100 g), total fat (per 100 g), and energy (Kcal per 100 g) in the selected chocolate confectioneries was conducted using IBM SPSS Statistics software. The data were analyzed and presented as mean \pm standard deviation. A one-way ANOVA test was performed to compare the total sugar, total fat, and energy content across different types of chocolates. Additionally, Pearson's correlation analysis was used to evaluate the relationships between the tested variables among the various chocolate confectioneries.

Table 1. Distribution and comparison of nutrient values between official website and on each product

| Products | Sugar (per 100g) | Fat (per 100g) | Energy (per 100g) | Net quantity | Official website values (per 100g) | | |
|---------------------------------------|---------------------|----------------------|----------------------|-----------------|---------------------------------------|--------------|-----------------|
| | | | | | Total sugar | Total fat | Total energy |
| CADBURY | | | | | | | |
| MILK CHOCOLATE | | | | | | | |
| 1] Dairy milk | 57 | 29.2 | 532 | 123 g | 57.3 | 28.9 | 534 |
| 2] Silk roasted almond | 46.7 | 35.2 | 560 | 143 g | 46.7 | 35.2 | 560 |
| 3] Silk plain | 55.3 | 31.4 | 543 | 150 g | 55.3 | 31.4 | 543 |
| 4] Silk bubbly | 55.3 | 31.4 | 543 | 120 g | 55.3 | 31.4 | 543 |
| 5] Silk Mousse | 47 | 34.8 | 552 | 116 g | 47 | 34.8 | 552 |
| 6] Silk fruit and nut | 50.9 | 30.4 | 532 | 137 g | 50.9 | 30.4 | 532 |
| 7] Silk Oreo | 48.3 | 34.9 | 562 | 130 g | 48.3 | 34.9 | 562 |
| 8] Cadbury chocolate fruit and nut | 52.3 | 28.6 | 522 | 80 g | | | |
| 9] Dairy milk crackle | 51.6 | 26 | 416 | 36 g | 51.8 | 25.8 | 508 |
| 10] Cadbury temptations almond | 45.2 | 35.1 | 555 | 72 g | | | |
| 11] Dairy milk crispello | 48.7 | 27.6 | 522 | 35 g | | | |
| 12] Dairy milk minis | 47.4 | 29.2 | 532 | 119 g | | | |
| 13] Silk minis | 55.3 | 31.4 | 543 | 153 g | | | |
| 14] Silk hazelnut | 46.6 | 36.8 | 566 | 143 g | 46.6 | 36.8 | 566 |
| 15] Silk Ganache | 48.5 | 36.5 | 567 | 158 g | 48.5 | 36.5 | 567 |
| 16] Dairy milk roast almonds | 46.9 | 33.7 | 551 | 36 g | 47.4 | 33.1 | 557 |
| 17] Dairy Milk In lickable | 47.8 | 25.6 | 492 | 20 g | 47.6 | 25.9 | 496 |
| 18] Cadbury bites almonds | 45.1 | 34.3 | 547 | 40 g | | | |
| 19] Cadbury bite hazelnut | 44.5 | 36.3 | 554 | 40 g | | | |

Table 1. Distribution and comparison of nutrient values between official website and on each product (continued)

| Products | Sugar (per 100g) | Fat (per 100g) | Energy (per 100g) | Net quantity | Official website values (per 100g) | | |
|---|---------------------|----------------------|----------------------|-----------------|---------------------------------------|--------------|-----------------|
| | | | | | Total sugar | Total fat | Total energy |
| CADBURY | | | | | | | |
| WAFER COATED | | | | | | | |
| 1] Perk | 44.9 | 25.4 | 512 | 22 g | | | |
| DARK HOCOLATE | | | | | | | |
| 1] Bournville 70% dark | 24.4 | 47.6 | 597 | 80 g | 24.2 | 48.6 | 623 |
| 2] Bournville 50% dark | 45.1 | 35 | 543 | 80 g | 46.7 | 34.6 | 556 |
| NESTLE | | | | | | | |
| MILK CHOCOLATE | | | | | | | |
| 1] Nestle Classic | 49.8 | 27.8 | 515 | 180 g | | | |
| WAFER COATED | | | | | | | |
| 1] Kit Kat | 25.6 | 39.2 | 461 | 38.5 g | 25.6 | 39.2 | 461 |
| 2] Kit Kat share pack | 35.1 | 25.5 | 445 | 123.2 g | 35.1 | 25.5 | 445 |
| 3] Munch treat | 32.9 | 23.4 | 435 | 160.2 g | 32.9 | 23.4 | 435 |
| 4] Munch | 30.6 | 23.1 | 429 | 18 g | | | |
| 5] Kit Kat dessert delight | 38.3 | 19.1 | 443 | 50 g | 38.3 | 19.1 | 443 |
| WHITE CHOCOLATE | | | | | | | |
| 1] Milky bar | 39.9 | 27.3 | 497 | 24.4 g | | | |
| HERSHEYS | | | | | | | |
| MILK CHOCOLATE | | | | | | | |
| 1] Kisses milk chocolate | 53.4 | 32 | 545 | 121.5 g | | | |
| 2] Kisses milk chocolate with almond | 47.5 | 34 | 552 | 113.4 g | | | |
| 3] Kisses milk chocolate with hazelnut | 49.1 | 33 | 548 | 33.6 g | | | |
| 4] Creamy milk | 51.8 | 32.1 | 553 | 40 g | 51.8 | 32.1 | 553 |
| 5] Creamy milk with whole almond | 44.7 | 35.3 | 567 | 40 g | 44.7 | 35.3 | 567 |

Table 1. Distribution and comparison of nutrient values between official website and on each product (continued)

| Products | Sugar (per 100g) | Fat (per 100g) | Energy (per 100g) | Net quantity | Official website values (per 100g) | | |
|--|---------------------|----------------------|----------------------|-----------------|---------------------------------------|--------------|-----------------|
| | | | | | Total sugar | Total fat | Total energy |
| HERSHEYS | | | | | | | |
| DARK CHOCOLATE | | | | | | | |
| 1] Exotic dark almond and black berry | 36.8 | 36.1 | 562 | 90 g | 36.5 | 36.3 | 564 |
| 2] Exotic dark almond and guava | 36.8 | 34.7 | 552 | 90 g | 36.5 | 34.8 | 554 |
| 3] Exotic dark blueberry | 64.7 | 13.7 | 453 | 33.3 g | 57.6 | 13.5 | 451 |
| 4] Exotic dark pomegranate | 64.7 | 13.7 | 453 | 33.3 g | 57.6 | 13.5 | 451 |
| 5] Exotic dark raspberry and goji | 64.7 | 13.7 | 453 | 33.3 g | 57.6 | 13.5 | 451 |
| 6] Hershey's 49% dark | 45.8 | 36.7 | 556 | 40g | 45.8 | 36.7 | 556 |
| WHITE CHOCOLATE | | | | | | | |
| 1] Kisses white chocolate | 54.4 | 29.7 | 534 | 100.8 g | 51.7 | 30 | 534 |
| GALAXY | | | | | | | |
| MILK CHOCOLATE | | | | | | | |
| 1] Galaxy smooth milk | 54.7 | 32.3 | 539 | 56 g | | | |
| 2] Galaxy milk chocolate with crispy | 50.5 | 29.2 | 528 | 56 g | | | |
| AMUL | | | | | | | |
| MILK CHOCOLATE | | | | | | | |
| 1] Amul India twilight tryst | 44.2 | 34 | 554 | 125 g | 33.8 | 36.9 | 568 |
| 2] Amul milk chocolate | 49.3 | 34.7 | 548 | 150 g | 40 | 31.4 | 545 |
| DARK CHOCOLATE | | | | | | | |
| 1] Amul dark chocolate 55% | 43 | 33.1 | 521 | 150 g | 43 | 33.7 | 557 |
| 2] Fruit and nut dark chocolate | 38.3 | 32.5 | 499 | 150 g | 37 | 34.2 | 556 |

Table 1. Distribution and comparison of nutrient values between official website and on each product (continued)

| Products | Sugar (per 100g) | Fat (per 100g) | Energy (per 100g) | Net quantity | Official website values (per 100g) | | |
|--------------------------------|---------------------|----------------------|----------------------|-----------------|---------------------------------------|--------------|-----------------|
| | | | | | Total sugar | Total fat | Total energy |
| AMUL | | | | | | | |
| WHITE CHOCOLATE | | | | | | | |
| 1] Super fruit white chocolate | 35.6 | 34.8 | 560 | 150 g | 50 | 27.4 | 524 |
| TOFFEE | | | | | | | |
| 1] Amul chocominis | 56.6 | 29.3 | 526 | 250 g | 50.7 | 31.1 | 541 |
| 2] Cadbury éclairs | 56.7 | 16 | 447 | 137.5 g | 55.7 | 14.8 | 447 |
| 3] Luvit éclairs | 49 | 15.7 | 449 | 390 g | | | |
| 4] Candyman éclairs | 58 | 10.3 | 412 | 273 g | 58 | 10.3 | 412 |
| 5] Alpenliebe éclairs | 66.5 | 6.8 | 407.7 | 136 g | | | |
| 6] Parle Melody | 53.8 | 12.8 | 428 | 391 g | | | |
| 7] Cadbury shots | 72.1 | 18.4 | 481 | 10.8 g | | | |
| 8] Amul almond | 35.2 | 41 | 590 | 200 g | 30.9 | 40.8 | 583 |

RESULTS

The mean and standard deviation of total sugar, total fat, and energy content for different types of chocolates were calculated, compiled, and tabulated. These values were correlated with various types of chocolate confectioneries, including milk chocolate, coated wafers, dark chocolate, white chocolate, and toffees.

The mean sugar content of the tested chocolates was 47.94 ± 9.68 g, the mean fat content was 29.06 ± 8.39 g, and the mean energy content was 515.82 ± 50.54 Kcal (Table 2).

Table 2. Mean amount of added sugars, fats and energy per 100gms of the product

| Parameter | Mean | Std. Deviation | N |
|---------------------------|--------|----------------|----|
| Sugar (Per 100g) | 47.94 | 9.68 | 56 |
| Fat (Per 100g) | 29.06 | 8.39 | 56 |
| Energy in Kcal (Per 100g) | 515.82 | 50.54 | 56 |

Toffees had the highest sugar content at 55.98 g, while coated wafers had the lowest at 34.56 g. Fat content was highest in dark chocolate at 32.25 g and lowest in toffees at 18.78 g. The highest energy content was observed in dark chocolate at 547 Kcal, while the lowest was in coated wafers at 454.17 Kcal (Table 3). The differences observed in total sugar, total fat, and total energy across the chocolate types were statistically significant ($p < 0.001$) (Table 3).

Therefore, the sequence of sugar content from highest to lowest was as follows: Toffee > Milk Chocolate > Dark Chocolate > White Chocolate > Coated Wafer. Similarly, for both fat content and energy content, the sequence was: Dark Chocolate > Milk Chocolate > White Chocolate > Coated Wafer > Toffee (Table 4).

Table 3. Mean sugar, fat and energy per 100gms of the product in different types of chocolate

| | | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Minimum | Maximum | p-value |
|----------------------------------|-----------------|--------|----------------|------------|----------------------------------|-------------|---------|---------|---------|
| | | | | | Lower Bound | Upper Bound | | | |
| Sugar (Per 100g) | Milk Chocolate | 49.177 | 4.012 | .733 | 47.678 | 50.675 | 39.900 | 57.000 | 0.000 |
| | Coated Wafer | 34.567 | 6.632 | 2.707 | 27.607 | 41.526 | 25.600 | 44.900 | |
| | White Chocolate | 46.430 | 13.953 | 4.412 | 36.449 | 56.411 | 24.400 | 64.700 | |
| | Dark Chocolate | 45.000 | 13.294 | 9.400 | -74.438 | 164.438 | 35.600 | 54.400 | |
| | Toffee | 55.988 | 11.089 | 3.921 | 46.717 | 65.258 | 35.200 | 72.100 | |
| Fat (Per 100g) | Milk Chocolate | 32.003 | 3.260 | .595 | 30.786 | 33.220 | 25.600 | 36.800 | 0.001 |
| | Coated Wafer | 25.950 | 6.894 | 2.814 | 18.716 | 33.184 | 19.100 | 39.200 | |
| | White Chocolate | 29.680 | 11.789 | 3.728 | 21.247 | 38.113 | 13.700 | 47.600 | |
| | Dark Chocolate | 32.250 | 3.606 | 2.550 | -.151 | 64.651 | 29.700 | 34.800 | |
| | Toffee | 18.787 | 11.167 | 3.948 | 9.451 | 28.124 | 6.800 | 41.000 | |
| Energy in KCal (Per 100g) | Milk Chocolate | 537.9 | 29.623 | 5.408 | 526.838 | 548.962 | 416.000 | 567.000 | 0.000 |
| | Coated Wafer | 454.17 | 30.334 | 12.38 | 422.333 | 486.001 | 429.000 | 512.000 | |
| | White Chocolate | 518.9 | 52.110 | 16.48 | 481.623 | 556.177 | 453.000 | 597.000 | |
| | Dark Chocolate | 547 | 18.385 | 13.00 | 381.819 | 712.181 | 534.000 | 560.000 | |
| | Toffee | 467.59 | 62.780 | 22.2 | 415.102 | 520.073 | 407.700 | 590.000 | |

Table 4. Mean sugar, fat and energy in 30g (1 serving) of chocolate

| Parameter | Type | Mean | Std. | Minimum | Maximum |
|----------------------------------|-----------------|---------|-----------|---------|---------|
| | | | Deviation | | |
| Sugar (Per 30gm) | Milk Chocolate | 14.753 | 1.204 | 11.970 | 17.100 |
| | Coated Wafer | 10.370 | 1.990 | 7.680 | 13.470 |
| | Dark Chocolate | 13.929 | 4.186 | 7.320 | 19.410 |
| | White Chocolate | 13.500 | 3.988 | 10.680 | 16.320 |
| | Toffee | 16.796 | 3.327 | 10.560 | 21.630 |
| Fats (Per 30gm) | Milk Chocolate | 9.601 | .978 | 7.680 | 11.040 |
| | Coated Wafer | 7.785 | 2.068 | 5.730 | 11.760 |
| | Dark Chocolate | 8.904 | 3.537 | 4.110 | 14.280 |
| | White Chocolate | 9.675 | 1.082 | 8.910 | 10.440 |
| | Toffee | 5.636 | 3.350 | 2.040 | 12.300 |
| Energy (Kcal per 30gm) | Milk Chocolate | 161.370 | 8.887 | 124.800 | 170.100 |
| | Coated Wafer | 136.250 | 9.100 | 128.700 | 153.600 |
| | Dark Chocolate | 155.670 | 15.633 | 135.900 | 179.100 |
| | White Chocolate | 164.100 | 5.515 | 160.200 | 168.000 |
| | Toffee | 140.276 | 18.834 | 122.310 | 177.000 |

There was a highly significant negative correlation between sugar and fat content ($r = -0.603$) and a significant negative correlation between sugar and energy content ($r = -0.259$). In contrast, a highly significant positive correlation was observed between fat and energy content ($r = 0.865$) (Table 5).

DISCUSSION

The present study assessed the sugar, fat, and energy content of various chocolate confectioneries. This is likely the first study of its kind conducted in India; therefore, direct comparisons with previous research are limited.

However, efforts were made to validate the findings through scientific reasoning. The analyzed data indicated that toffees had the highest sugar content per serving, followed by milk chocolate, dark chocolate, white chocolate, and coated wafers with the lowest sugar content. Toffees are typically prepared as high-sugar boiled confections, using brown sugar, glucose syrup, or inverted sugar as primary ingredients, which are either deposited into chocolate shells or layered onto the toffee.

The extrinsic sugars added during toffee processing, combined with the intrinsic sugars present in the boiled confectionery, likely contribute to the high sugar content observed in toffees.

Table 5. Correlation analysis between the sugar, fat and energy of the products

| Parameters | | Sugar (Per 100g) | Fat (Per 100g) | Energy in KCal (Per 100g) |
|--------------------------------------|---------------------|---------------------|-------------------|------------------------------|
| Sugar (Per 100g) | Pearson correlation | 1 | -.603 | -.259 |
| | p-value | | .000 | .050 |
| Fat (Per 100g) | Pearson correlation | -.603 | 1 | .865 |
| | p-value | .000 | | .000 |
| Energy in Kcal (Per 100g) | Pearson correlation | -.259 | .865 | 1 |
| | p-value | .050 | .000 | |

Milk chocolate contains less sugar than toffees due to its higher proportion of milk solids and cocoa butter, with less than 35% cocoa content. Dark chocolate has even lower sugar content compared to milk chocolate, as it is made by combining a higher percentage of cocoa (65–90%) with cocoa butter (10–35%) instead of milk solids. White chocolate contains less sugar than toffees, milk chocolate, and dark chocolate, despite its high proportion of sugar, as it also includes significant amounts of milk and cocoa butter.¹⁴⁻²⁰ Coated wafer chocolates have the lowest sugar content, as they are primarily made from flour and water, with only a chocolate coating contributing to the sugar content, resulting in minimal overall sugar levels.^{21,22}

The findings of the present study indicate variations in sugar, fat, and energy content across different types of chocolates, primarily due to differences in the ingredients used and the varying proportions of added sugar to enhance palatability. Dark chocolates typically contain less sugar, as they are processed and marketed to emphasize their potential health benefits. In contrast, milk chocolates have higher sugar content due to the addition of significant amounts of sugar during production.

A study²³ examining the daily consumption of 25 g of different chocolates over three months

showed that intake of milk chocolate and white chocolate significantly increased blood glucose levels. In contrast, consuming dark chocolate was found to be a better option,¹⁴ as it contains five times more polyphenols and flavonoids compared to milk and white chocolates. Additionally, the fat and sugar content in milk and white chocolates is higher than that in dark chocolate.²³

This study demonstrated a positive relationship between fat and energy content in the tested chocolates. Dark chocolate exhibited the highest fat content due to its high proportion of cocoa and cocoa butter,²³ resulting in increased energy content, followed by milk chocolate, white chocolate, coated wafers, and toffees. A negative correlation was observed between fat and sugar content, as chocolates with higher sugar levels tended to have lower fat content. This aligns with findings from previous studies indicating that chocolates with reduced sugar content typically contain higher fat levels.²⁴ This pattern was particularly evident in dark chocolates in this study. The mean fat content of the chocolate samples was 29.06% per 100 g, which translates to 8.7% per 30 g serving. The World Health Organization, along with dietary guidelines and Dietary Reference Intakes, recommends that daily fat intake should constitute between 20% and 35% of total caloric intake. Public awareness regarding the fat content

per serving is essential to support informed decisions and prevent excessive fat consumption.

A negative relationship was observed between sugar and energy content in the tested chocolates. Dark chocolate provided the highest energy, followed by milk chocolate, white chocolate, toffee, and coated wafers. This can be attributed to the fact that one gram of carbohydrate provides 4 calories, whereas one gram of fat provides 9 calories.²⁵ Consequently, dark chocolates, which contain less sugar but more fat, deliver higher energy. Regardless of variations in sugar, fat, and energy content, the consistency and timing of chocolate consumption play a significant role in its adverse effects on dental health, making it an important risk factor for dental caries.

However, chocolate has been associated with positive health benefits, particularly in cardiovascular and metabolic diseases.²⁶ It has also demonstrated potential benefits in managing Alzheimer's disease.²⁷ Higher chocolate consumption has been linked to a 37% reduction in heart attacks and a 29% lower risk of stroke.²⁸ Dark chocolate helps prevent the hardening of arteries and reduces the adhesion of white blood cells to arterial walls. Additionally, chocolate protects cell membranes, increases HDL cholesterol levels, and prevents plaque formation in arteries.^{20 23} It exhibits anti-inflammatory properties, protects the skin from UV radiation, and has beneficial effects on satiety, cognitive function, and mood. Daily intake of dark chocolate significantly reduced mood disturbances in individuals consuming 85% cocoa chocolate, though this effect was not observed in those consuming 70% cocoa chocolate.²⁹

The consistency of sugar, particularly when it has low solubility and slower oral clearance, poses a greater risk for tooth decay than the overall quantity consumed. Nevertheless, sugar remains a common risk factor for both dental caries and

metabolic disorders, making chocolate consumption a significant health concern. In the UK, the sugar content in chocolate confectionery has increased significantly since 1992, prompting recommendations to reduce sugar levels in chocolate products.³⁰ In India, per capita sugar consumption rose from 22 g/day in 2000 to 55.3 g/day in 2010, while total fat consumption increased from 21.2 g/day to 54 g/day over the same period. Chocolate consumption in India has nearly doubled since 2008, with a sharp rise from 40 g in 2008 to 70 g in 2011. Chocolate ranks among children's favorite foods, with 92% of children and 90% of both non-professionals and professionals consuming chocolate daily.³¹ Children aged 4–8 and 9–12 show higher rates of chocolate consumption, with 68.5% of total chocolate intake observed in the 3–12 age group.²⁴ Research has also shown that chocolate reduces the microhardness of enamel in both permanent and primary teeth, increasing susceptibility to dental caries.³²

High fat content in the Indian diet is a leading contributor to obesity, diabetes, and cardiovascular diseases.³³ The average fat intake from all sources in India is approximately 44.4 g per person per day, which exceeds the Indian Council of Medical Research (ICMR) recommendation of 25–40 g per day. Regular chocolate consumption further increases the risk of excessive fat accumulation in the body. This underscores the need for the general population to make informed choices regarding chocolate consumption to avoid surpassing the recommended dietary fat limits.³³

Chocolate offers both health benefits and potential health risks. Dark chocolate has been shown to satisfy hunger with fewer adverse effects,³⁴ whereas other types of chocolates may increase hunger and promote overeating, leading to weight gain. While dark chocolate is a healthier option compared to other varieties, it should still

be consumed in moderation, as excessive consumption of any type of chocolate can be harmful. Studies comparing the cariogenicity of dark chocolate and milk chocolate suggest that dark chocolate is less cariogenic. This is because milk chocolate contains milk, which reduces the anti-cariogenic properties of cocoa.³⁵ In addition to being less cariogenic, dark chocolate has demonstrated prebiotic effects on gut microbiota, enhancing digestive efficiency. These benefits are attributed to the polyphenol and alkaloid content of cocoa.^{36 37} Reducing the sugar content or incorporating artificial sweeteners can help preserve the beneficial properties of cocoa, making chocolate a healthier snack option.³⁵

The present study highlights significant variations in sugar, fat, and energy content among different brands of chocolate confectioneries. While the exact scientific reasons for these variations were beyond the scope of this study, further research is needed to standardize sugar content, minimize health risks, and raise awareness about the nutritional composition of chocolates to support informed choices. This study was limited to a select number of available chocolate products; therefore, future research with larger sample sizes is necessary to generalize the findings and identify the healthiest options.

CONCLUSIONS

Chocolate remains a universally favored treat, often consumed without consideration of its nutritional value. This study assessed the total sugar, total fat, and energy content of various chocolate confectioneries. Discrepancies were observed between the nutritional information provided on official websites and that found on products obtained from supermarkets. An inverse relationship was identified between sugar content and both fat and energy levels, while a direct relationship was observed between fat and energy

content. These findings suggest that chocolates with lower sugar and higher fat and energy content may help reduce the risk of dental caries. However, increased fat consumption is associated with a higher risk of metabolic diseases. Therefore, selecting chocolates should be guided by individual nutritional requirements for sugar, fat, and energy to balance potential health benefits and risks.

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