

DEVELOPMENT AND EVALUATION OF MULTI-NUTRIENT BREAKFAST BARS FOR SCHOOL- CHILDREN AGED 7-12 YEARS:

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ABSTRACT:

Breakfast is essential for school-aged children's growth, brain development, and general health. However, a lot of kids either miss breakfast or eat meals deficient in vital nutrients because of their fast-changing lifestyles, time limitations, and inadequate nutritional awareness. Convenient, nutrient-dense, and enticing breakfast options that are suited to children's nutritional requirements are required to respond to this growing concern. The two different variants of the breakfast bars were formulated using millets and rice flakes respectively. The results of the proximate analysis depicted that millet bar contained 50.93% of carbohydrates, 9.40% of protein, 14.92% of fats. Whereas the rice flakes bar had 46.41% of carbohydrates, 15.79% of protein, 27.50% of fats. The mineral estimation showed the presence of 45.93mg/kg of iron in millet bar and 77.48mg/kg of iron in rice flakes bar. Alongside the vitamin estimation was also performed which showed in which millet bar contained 2.92mg (per 100g) of Vitamin E and rice flakes bar. Sensory analysis was conducted by a panel of semi trained members using a 9-point hedonic scale to evaluate the bars and high credibility was gained in regards to taste, texture, appearance and overall acceptability. According to the study's findings, multi nutrient breakfast bars can be a healthy, kid-friendly, and efficient breakfast choice.

INTRODUCTION

Breakfast has been shown to be crucial for school-age children's cognitive development and nutritional health. The significance of breakfast has an essential part in a daily diet, particularly for school-age children as it restores glucose levels following an overnight fast and supplies vital nutrients for growth, cognitive function, and general health, the morning meal is often referred to as perhaps the most significant meal of the day [1] Rapid and significant changes in physical and cognitive development have a direct impact on children's health, academic performance, and future productivity. Since inadequate nutrition throughout these years can have permanent effects and prolong cycles of deprivation and illness, the international nutrition agenda needs to be reviewed to include targeted strategies for this age group [2]

Numerous studies have demonstrated an elevated incidence of undernutrition, which can be attributed to a number of factors, including insufficient varied diets, poor sanitation, gender disparities, poverty, and low health awareness. Adolescent undernutrition in India has an impact on future health outcomes, academic achievement, immunity, and physical development. [3] Breakfast consumption majorly contributes to the appropriate dietary and health aspects of children, School-aged children who regularly eat breakfast have improved nutritional status, academic performance, and cognitive function. Skipping breakfast may have a detrimental impact on memory, attention, and mental agility, according to the theory that links overnight fasting, early morning levels of energy, and subsequent brain function [4]

The need of the study on formulation of nutrient dense breakfast bars is considered as a serious aspect like it is crucial to investigate easy, scalable, and culturally acceptable food-based strategies. The potential of

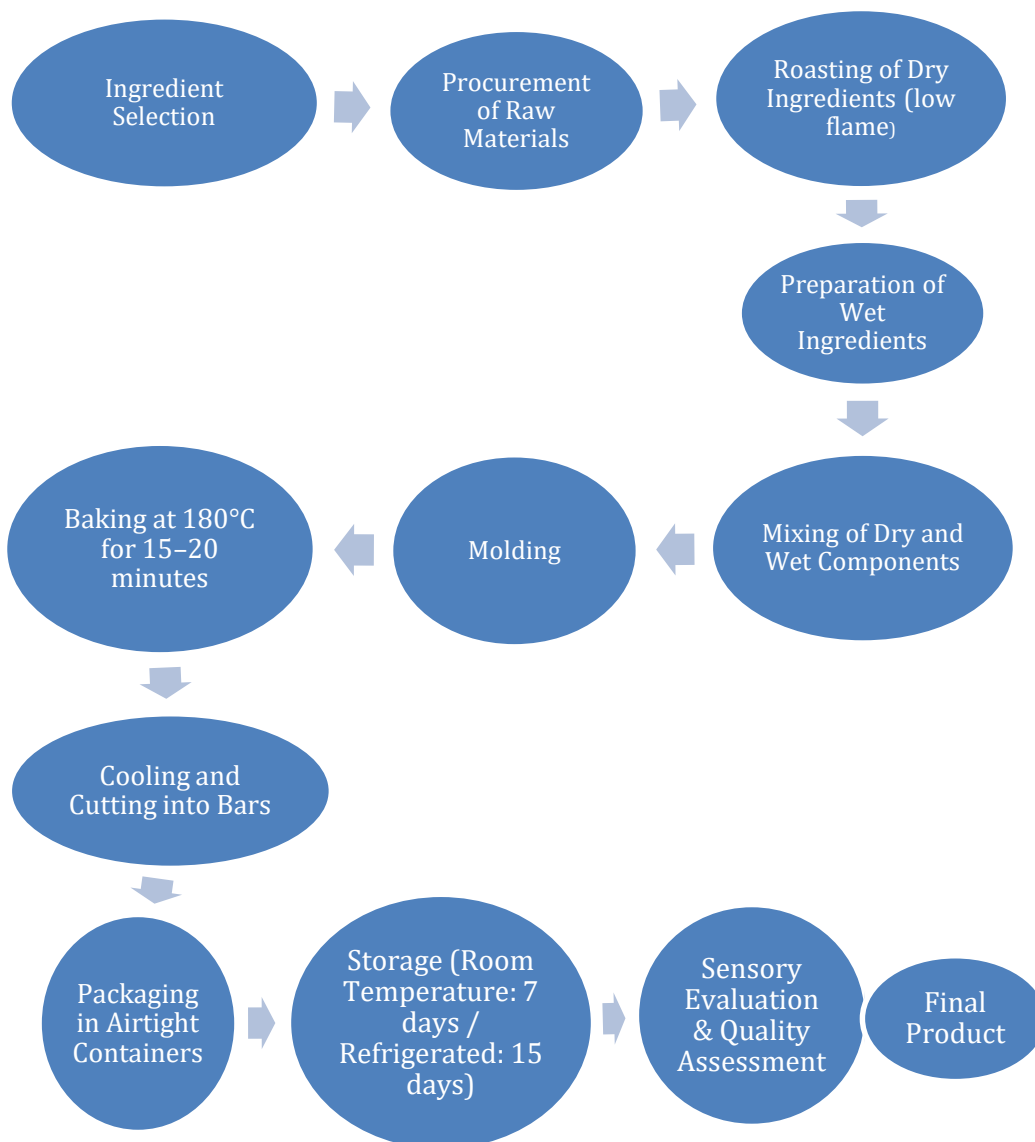
nutrient bars and other fortified food products as efficient means of providing nutrients to populations that are at risk through long-term dietary interventions. [5]

Preventive measures can be used like a school-based, multi-component nutrition education intervention program designed as six structured sessions using interactive lectures, group discussions, posters, videos, and audio-visuals. The intervention, grounded in the Theory of Planned Behaviour, aimed at enhancing nutrition knowledge, attitudes, and perceived behavioural control to encourage healthy eating intentions among school-going adolescents and aid in malnutrition prevention. [6]

MATERIALS & METHODS

The main aim of the work was to develop and evaluate multi-nutrient breakfast bars that are convenient alternatives for traditional breakfast for school children aged 7–12 years.

Product Development:



The development of product was carried out sequentially. Initially ingredients that were necessary to prepare the nutrient bars were selected. Red rice flakes, millets, and oats were the three base ingredients used to make the three different kinds of bars. Ingredients were chosen based on their functional qualities and nutrient density. Millets, red rice flakes, and oats are the nutrient-dense base ingredients that provide complex carbohydrates, dietary fibre, and a rich number of antioxidants, which is important for sustained energy release and metabolic health. Nuts, seeds, natural sweeteners (dates and raisins), coconut oil, and peanut butter enhance the mix with high-quality fats, protein, binding properties, and improved palatability, while cinnamon adds flavour and has antioxidant and glycaemic-modulating properties.

The dry ingredients like peanuts, almonds, sesame seeds, flaxseeds, oats, rice flakes, and millets were lightly roasted. To that peanut butter and coconut oil were added. In addition to that dates and raisins were combined to create a paste that functioned as a sweetener and binding agent. The flaxseed gel and spices like cinnamon were added to the millet-based bar as a replacement for dates and raisins to give a different flavour. The mixture was then transferred to a mold which had been greased with coconut oil and were allowed to settle.

The product was baked for the time interval of 15 to 20 minutes at 180°C and was kept aside to cool.



Breakfast bars

PROXIMATE ANALYSIS:

Parameters	Method of analysis
Carbohydrates	AOAC method
Fat	Soxhlet extraction
Protein	Kjeldahl method
Ash	Total ash content
Moisture	Oven dry

SENSORY ANALYSIS:

Sensory evaluation was used to determine the rate, acceptance of the food product that was developed. Hedonic scale was used to determine the rate of acceptance where the scale ranges from 1= dislike extremely to 9=extremely like. The hedonic scale consists of different attributes which includes taste, texture, colour, appearance, flavour etc., to determine the rate of acceptance.

SHELF-LIFE:

By tracking changes in sensory attributes, the Shelf-Life was evaluated by keeping the variants packed in an air tight container separately under room temperature and also refrigerator for a time span of 15 days. And the

constant monitoring was done and the changes in the physical characteristics like colour, flavour, taste, appearance were recorded.

STATISTICAL ANALYSIS:

Statistical analysis was performed using Microsoft Excel that was used to find the mean of the sensory analysis, which indicated average acceptance of variants categorized under different attributes and represented it with the graph.

RESULTS

The sensory qualities of the variants were assessed by a panel of semi trained members using 9-point Hedonic scale which concluded that the breakfast bars were rated 7 or more than 7 in all of the sensory attributes. According to the findings, the breakfast bars offered an appropriate profile of nutrients critical to children's growth and well-being. The taste and texture of the bars were deemed to be very acceptable by sensory evaluation, which made them a good choice for frequent consumption.

The variants developed were highly accepted and were considered to have good flavour and taste accordingly.

Attributes	M±SD
Taste	8.2 ± 0.64
Texture	8.2 ± 0.67
Appearance	8.1 ± 0.73
Colour	8.2 ± 0.77
Flavour	8.2 ± 0.69
Overall acceptability	8.2

Sensory Evaluation score of Standard

The above table depicts the sensory evaluation of the standard food product developed, which indicates the mean values of different attributes, among which taste has a mean of 8.2 ± 0.64, texture has a mean of 8.2 ± 0.67, appearance has a mean of 8.1 ± 0.73, colour has a mean of 8.2 ± 0.77, flavour has a mean of 8.2 ± 0.69.the overall acceptability mean is 8.2.

Attributes	M±SD
Taste	7.7 ± 0.58
Texture	7.7 ± 0.65
Appearance	7.7 ± 0.86
Colour	7.7 ± 0.64
Flavour	7.9 ± 0.60
Overall acceptability	7.9

Sensory Evaluation score of Variant A

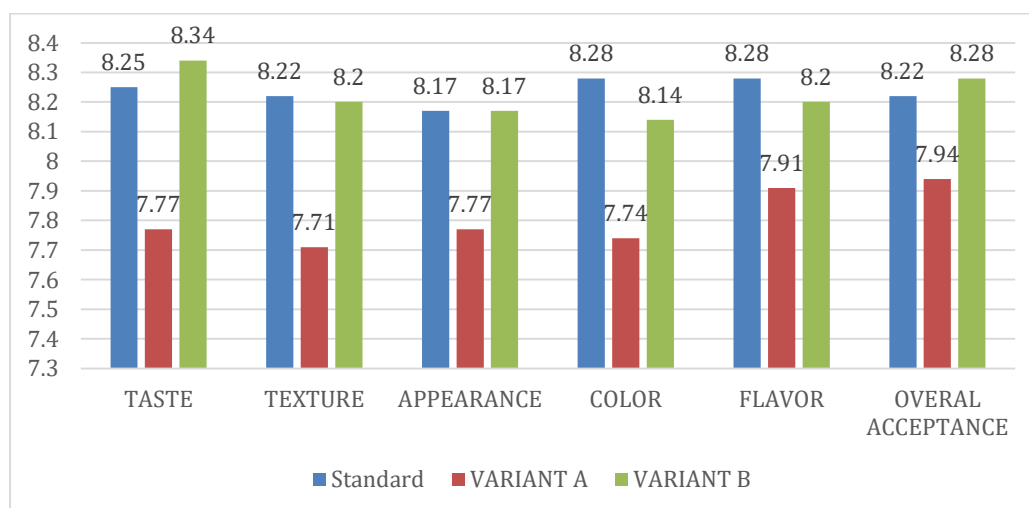
The above table depicts the sensory evaluation of Variant A, which indicates the mean values of different attributes, among which taste has a mean of 7.7 ± 0.58 , texture has a mean of 7.7 ± 0.65 , appearance has a mean of 7.7 ± 0.86 , colour has a mean of 7.7 ± 0.64 , flavour has a mean of 7.9 ± 0.60 . the overall acceptability mean is 7.9.

Attributes	M±SD
Taste	8.3 ± 0.53
Texture	8.2 ± 0.57
Appearance	8.1 ± 0.73
Colour	8.1 ± 0.68
Flavour	8.2 ± 0.66
Overall acceptability	8.2

Sensory Evaluation score of Variant B

The above table depicts the sensory evaluation of the Variant B, which indicates the mean values of different attributes, among which taste has a mean of 8.3 ± 0.53 , texture has a mean of 8.2 ± 0.57 , appearance has a mean of 8.1 ± 0.73 , colour has a mean of 8.1 ± 0.68 , flavour has a mean of 8.2 ± 0.66 . the overall acceptability mean is 8.2.

	STANDARD	VARIANT A	VARIANTB
OVERALL ACCEPTIBILITY	8.2	7.9	8.2



PROXIMATE ANALYSIS OF THE VARIANTS:

Nutrients	Standard	Variant A	Variant B
Moisture%	8.03	20.98	8.18
Total ash %	2.29	3.77	2.12
Carbohydrates%	45.58	50.93	46.41
Proteins%	16.82	9.40	15.79
Fat%	27.28	14.92	27.50
Iron mg/100g	39.38	45.93	77.48
Vitamin E mg/100g	9.0	2.92	8.65

Nutrients	RDA	1/3 rd portion of the RDA	Variant B	Adequacy
Carbohydrates(g/100g)	130g/d	44g/d	46.41	105.4%
Proteins(g/100g)	23-33g/d	11g/d	15.79	143.5%
Fat(g/100g)	50-70g/d	24g/d	27.50	114.5%
Iron mg/100g				
a) Children(7-9yrs)	15mg/d	5mg/d	7.74	154.8%
b) Boys (10-12yrs)	16mg/d	5.3mg/d		146.03%
c) Girls (10-12yrs)	28mg/d	9.3mg/d		83.22%

On comparison with 1/3rd portion of the standard ranges of the RDA, the nutritional analysis of the Variant B showed that the nutrients nearly met the standard ranges. The interpretation of the adequacy % was Carbohydrates nearly met the ideal range. Proteins, fats and iron are slightly high from ideal range but are acceptable. **(Reference: ICMR 2020)**

SHELF LIFE:

The shelf-life state observed after 7 days showed that there were no changes in the sensory attributes of the product stored under refrigerator conditions whereas the product that were stored under room temperature had slight changes in the taste.

The shelf-life state observed after 15 days showed that there were no changes in the sensory attributes of the product stored under refrigerator conditions whereas the product that were stored under room temperature had major changes in all attributes like taste, texture, appearance and aroma.

Hence the shelf-life analysis depicted that the product variants that were developed can be stored for up to 7 days under normal conditions and up to 15 days under refrigerator conditions.



Room temperature conditions for 7 days



Refrigerator conditions for 7 days



DAY 1



DAY 7



DAY 15

Room temperature conditions for 15 days



Refrigerator conditions for 15 days

DISCUSSION

The study emphasizes the multinutrient breakfast bars' sensory appeal and nutritional sufficiency as useful substitutes for kids. With an elevated protein and iron level, the rice flakes-based bar has great potential to help schoolchildren in India who suffer from iron deficiency. Because of the increased carbohydrate and vitamin E content, the millet-based bar offers long-lasting energy and antioxidant advantages. According to sensory data, the compositions were generally well-received, which is consistent with earlier studies on functional and fortified kid-friendly snack foods. These bars can lessen the problems of skipping breakfast and consuming insufficient amounts of nutrients, especially in cities where people's time frequently prevents them from eating a healthy breakfast. Notwithstanding the encouraging results, the study had several drawbacks, such as an inadequate sensory panel and a brief shelf-life testing period. In order to evaluate the long-term effects of such products on children's dietary habits, academic performance, and general health outcomes, future research could concentrate on larger-scale intervention studies. To investigate the possibility of incorporating these products into healthcare campaigns, cost and scalability analyses would also be helpful.

CONCLUSION

The goal of the current study was to create multi-nutrient breakfast bars as a convenient, healthy, and socially acceptable substitute for traditional breakfast for school-age children (7–12 years old). Nutrient-rich ingredients like oats, millets, red rice flakes, flaxseeds, sesame seeds, nuts, and dried fruits can be successfully incorporated into a product to make it both palatable and kid-friendly, and it can also make a substantial contribution to daily nutritional needs. The breakfast bars nutritional analysis showed that they contained a balanced mix of macronutrients, especially proteins and carbs, as well as dietary fibre and vital micro nutrients like iron and calcium. These nutrients are essential for school-aged children's immune system, cognitive development, and physical growth, but they are frequently absent from their diets. Selected panellists' sensory evaluation revealed that the breakfast bars were praised for their overall appeal, taste, texture, aroma, and appearance.

The most popular formulations among those made combined sensory appeal and nutritional sufficiency, making them appropriate for children to regularly consume. This study supports the possibility of creating novel food products targeted at enhancing child nutrition by utilizing affordable, readily available, and useful ingredients. The breakfast bar created for this study can be used as an aspect of school meal programs, as a convenient mid-morning snack, or as an economical option for hectic mornings. Additionally, it presents a chance for commercial use in the expanding market for kid-friendly, health-conscious foods. To sum up,

creating multi-nutrient breakfast bars is a practical and effective way to address school-age children's nutrient deficiencies and breakfast skipping. The effect of consistent intake on the children's well-being and academic performance can be evaluated through large-scale trials, long-term storage stability evaluation, and formulation variety expansion.

FUTURE LINE OF WORK

- Investigate adding probiotics, vitamin D, vitamin B12, iodine, or other fortified nutrients to the breakfast bars to improve their functional value and more thoroughly address regional deficiencies.
- Examine whether producing these bars on a large scale is cost-effective and whether incorporating them into government run initiatives like midday meals or community nutrition initiatives is feasible.
- To accommodate local preferences, seasonal availability, and particular dietary requirements (such as gluten free, nut free, or vegan substitutes), develop and test a number of variations using ingredients that are readily available in the area.

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