# Jana Publication & Research

## ENHANCING PDF MALWARE CLASSIFICATION USING CTGAN-BASED DATA AUGMENTATION AND SUPERVISED LEA...

VRC08

### Document Details

Submission ID
trn:oid:::2945:312922019

Submission Date
Sep 18, 2025, 9:17 AM GMT+5:30

Download Date
Sep 18, 2025, 9:21 AM GMT+5:30

File Name
IJAR-53887.pdf

File Size
2.9 MB

60 Pages

14,673 Words

80,230 Characters

# 18% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

## Filtered from the Report

- Bibliography
- Quoted Text

## Match Groups

**179** Not Cited or Quoted 18%
Matches with neither in-text citation nor quotation marks

**4** Missing Quotations 0%
Matches that are still very similar to source material

**0** Missing Citation 0%
Matches that have quotation marks, but no in-text citation

**0** Cited and Quoted 0%
Matches with in-text citation present, but no quotation marks

## Top Sources

11% Internet sources
12% Publications
12% Submitted works (Student Papers)

## Match Groups

- 179 Not Cited or Quoted 18%
  Matches with neither in-text citation nor quotation marks
- 4 Missing Quotations 0%
  Matches that are still very similar to source material
- 0 Missing Citation 0%
  Matches that have quotation marks, but no in-text citation
- 0 Cited and Quoted 0%
  Matches with in-text citation present, but no quotation marks

## Top Sources

- 11% Internet sources
- 12% Publications
- 12% Submitted works (Student Papers)

## Top Sources

The sources with the highest number of matches within the submission. Overlapping sources will not be displayed.

| | | |
|---|---|---|
| 1 | Internet | epdf.pub 4% |
| 2 | Internet | dn720001.ca.archive.org 1% |
| 3 | Internet | casadesante.com <1% |
| 4 | Student papers | University of Delhi on 2025-08-07 <1% |
| 5 | Student papers | University of Nevada Reno on 2018-11-26 <1% |
| 6 | Student papers | J S S University on 2025-06-23 <1% |
| 7 | Publication | "Millets: The Multi-Cereal Paradigm for Food Sustainability", Springer Science and... <1% |
| 8 | Student papers | Herzing University on 2024-06-23 <1% |
| 9 | Student papers | University of West London on 2025-04-26 <1% |
| 10 | Internet | dokumen.pub <1% |

| | | |
|---|---|---|
| 11 | Publication | "Global Millets Production for a Sustainable Future", Springer Science and Busine... <1% |
| 12 | Publication | Darshan Malik, Nandita Narayanasamy, V A Pratyusha. "Essential Laboratory Tec... <1% |
| 13 | Student papers | parsurnd on 2025-05-02 <1% |
| 14 | Publication | Saafi, E.B.. "Protective effect of date palm fruit extract (Phoenix dactylifera L.) o... <1% |
| 15 | Internet | www.vitalojas.com <1% |
| 16 | Student papers | The University of the West of Scotland on 2023-04-07 <1% |
| 17 | Student papers | University of Western Sydney on 2025-05-04 <1% |
| 18 | Internet | www.soymilkquick.com <1% |
| 19 | Publication | Muhammad Fawwaz Khairuddin, Hasnah Haron, Hanis Mastura Yahya, Nur Ain H... <1% |
| 20 | Student papers | University of Limerick on 2025-03-22 <1% |
| 21 | Student papers | University of New England on 2024-09-18 <1% |
| 22 | Publication | B. Sasikumar, Santhosh J. Eapen. "Spices Production to Products - Purity and Auth... <1% |
| 23 | Publication | Mostafa Mahmoud Hegazy, Mohamed Fawzy Ramadan. "Natural Remedies in Dis... <1% |
| 24 | Student papers | Universiti Tunku Abdul Rahman on 2025-04-24 <1% |

25 Student papers

ebsu on 2023-01-31 <1%

26 Publication

Babafemi Raphael Babaniyi, Sesan Abiodun Aransiola, Gabriel Gbenga Babaniyi, ... <1%

27 Student papers

Croydon College on 2024-10-30 <1%

28 Publication

Khalid Bashir, Kulsum Jan, Vaibhav Kumar Maurya, Amita Shakya. "Food Fortificat... <1%

29 Student papers

Liverpool John Moores University on 2021-03-05 <1%

30 Publication

N. Gandhi, Y. Rama Govinda Reddy, K. Rama Naik, K. Mounika, Ch. Vijaya. "Develo... <1%

31 Student papers

The Scientific & Technological Research Council of Turkey (TUBITAK) on 2025-05-11 <1%

32 Internet

ebin.pub <1%

33 Student papers

University of Greenwich on 2024-04-18 <1%

34 Internet

www.parsidairyfarm.com <1%

35 Publication

Krishan Dutt Sharma, Satish Kumar, Rakesh Sharma, Raj K. Keservani. "Functiona... <1%

36 Student papers

National University of Singapore on 2012-04-03 <1%

37 Internet

hq.moh.gov.my <1%

38 Internet

irgu.unigoa.ac.in <1%

39 Internet
www.bestonhealth.com <1%

40 Student papers
Higher Education Commission Pakistan on 2025-02-21 <1%

41 Publication
Ilyas Ahmad, Zia-ur-Rehman Mashwani, Zohaib Younas, Tayyaba Yousaf. "LCMS B... <1%

42 Student papers
New College Swindon on 2025-02-02 <1%

43 Publication
Rosalva Mora-Escobedo, Gloria Dávila-Ortiz, Gustavo F. Gutiérrez López, José J. Be... <1%

44 Student papers
University of Wales Institute, Cardiff on 2024-08-11 <1%

45 Internet
bugoutbill.com <1%

46 Internet
www.researchandmarkets.com <1%

47 Internet
www.slideshare.net <1%

48 Student papers
Federal University of Technology on 2016-10-19 <1%

49 Publication
Leo M.L. Nollet, Javed Ahamad. "Bioactive Compounds of Edible Oils and Fats - He... <1%

50 Student papers
University of Wales Institute, Cardiff on 2024-06-30 <1%

51 Internet
cafesajawal.pk <1%

52 Internet
recipes.timesofindia.com <1%

53 Internet
www.epainassist.com <1%

54 Internet
www.jagranjosh.com <1%

55 Student papers
MAHSA UNIVERSITY (NEW LMS) on 2025-07-29 <1%

56 Student papers
Oxford & Cherwell Valley College on 2023-04-01 <1%

57 Student papers
Solihull College, West Midlands on 2025-02-04 <1%

58 Student papers
University of Nevada Reno on 2019-05-06 <1%

59 Internet
en.wikipedia.org <1%

60 Internet
www.ayurveda-distancelearning.com <1%

61 Publication
"Bioactive Molecules in Food", Springer Science and Business Media LLC, 2019 <1%

62 Publication
Daniel Anokwah, Evelyn Asante-Kwatia, Yakubu Jibira, Isaac Kingsley Amponsah e... <1%

63 Student papers
Federal University of Technology on 2023-07-13 <1%

64 Publication
G Sethuram Rao, D. Vydeki, G. Shanmugaraj. "chapter 5 Women Millets and Susta... <1%

65 Student papers
University of Bedfordshire on 2017-01-25 <1%

66 Student papers
University of Surrey on 2025-05-22 <1%

67 Internet
forgottenportal.com <1%

68 Internet
harvest.usask.ca <1%

69 Internet
sansthaan.com <1%

70 Internet
studyres.com <1%

71 Internet
www.aboissa.com.br <1%

72 Internet
www.chemijournal.com <1%

73 Internet
www.chocolate.wiki <1%

74 Internet
www.uwex.edu <1%

75 Student papers
American University of Beirut on 2020-02-24 <1%

76 Student papers
Federal University of Technology on 2024-10-19 <1%

77 Publication
Haroon Khan, Muhammad Ajmal Shah, Tarun Belwal, Eduardo Sobarzo-Sánchez. "... <1%

78 Student papers
Higher Education Commission Pakistan on 2025-05-13 <1%

79 Student papers
National University of Singapore on 2012-03-27 <1%

80 Student papers
National University of Singapore on 2020-03-15 <1%

81 Student papers
North Lindsey College on 2015-03-04 <1%

82 Student papers
Pennsylvania State System of Higher Education on 2015-10-17 <1%

83 Publication
Polysaccharides, 2015. <1%

84 Student papers
University of Lincoln on 2023-12-08 <1%

85 Student papers
William Jewell College on 2007-04-29 <1%

86 Internet
chimie-biologie.ubm.ro <1%

87 Internet
downloads.clashofminds.com <1%

88 Internet
escholarship.mcgill.ca <1%

89 Internet
etheses.whiterose.ac.uk <1%

90 Internet
jifro.ir <1%

91 Internet
jmhg.springeropen.com <1%

92 Internet
ojs-journey.pib.ac.id <1%

93 Internet
pmc.ncbi.nlm.nih.gov <1%

94 Internet
www.ambeed.com <1%

95 Internet
www.josephflach.co.uk <1%

96 Publication
"Changes in Official Methods of Analysis Made at the 89th Annual Meeting, Octob... <1%

97 Student papers
Bedford College Group on 2024-11-25 <1%

98 Student papers
Cornell University on 2024-04-12 <1%

99 Student papers
Higher Education Commission Pakistan on 2011-07-22 <1%

100 Student papers
Institute of Technology, Sligo on 2025-04-14 <1%

101 Student papers
Monash University on 2025-08-23 <1%

102 Student papers
Montana State University, Bozeman on 2022-03-29 <1%

103 Student papers
National University of Singapore on 2020-03-15 <1%

104 Student papers
New International School of Thailand on 2005-01-22 <1%

105 Student papers
Roma Mitchell Secondary College on 2025-08-19 <1%

106 Publication
Shrikaant Kulkarni, A. K. Haghi, Om M. Bagade, Bimlesh Kumar. "Ecotoxicity and ... <1%

107 Student papers
St Ursula's College on 2025-09-10 <1%

108 Publication
Suman Thamburaj, Rajendran Palanivel, Paranthaman Ramakrishnan, Vidyalaksh... <1%

109 Student papers

UOW Malaysia KDU University College Sdn. Bhd on 2025-04-23 <1%

110 Student papers

University of Queensland on 2018-06-01 <1%

111 Student papers

University of Surrey on 2025-02-17 <1%

112 Student papers

University of Witwatersrand on 2025-05-21 <1%

113 Student papers

Wageningen University on 2025-04-22 <1%

114 Student papers

Wayne State University on 2024-10-19 <1%

115 Internet

core.ac.uk <1%

116 Internet

kupdf.net <1%

117 Internet

listens.online <1%

118 Internet

nmbu.brage.unit.no <1%

119 Internet

pub.epsilon.slu.se <1%

120 Internet

repository.tudelft.nl <1%

121 Internet

researchspace.ukzn.ac.za <1%

122 Internet

soeagra.com <1%

123 Internet
store.additionbooks.com <1%

124 Internet
www.aryanint.com <1%

125 Internet
www.bhumipublishing.com <1%

126 Internet
www.coursehero.com <1%

127 Internet
www.ros.hw.ac.uk <1%

128 Publication
"Dates", Wiley, 2013 <1%

129 Student papers
Beirut Arab University on 2024-08-07 <1%

130 Publication
Béda Franck Yapo, Ginette Gladys Doué, Patrick Aubin Dakia, Yapo Hypolithe Kou... <1%

131 Publication
Fidel Toldrá, Leo M.L. Nollet. "Handbook of Dairy Foods Analysis", CRC Press, 2021 <1%

132 Publication
R.A. Ilyas, M.I.H.M. Tahir, Muhammad Asyraf Muhammad Rizal, S.M. Sapuan, M.S.... <1%

133 Publication
Tariq Khan, Azaz Ahmad Azad, Rayees Ul Islam. "Millets: A comprehensive review ... <1%

134 Publication
Abdollahikhamene, Hojjat. "Effect of Six-Day Germination on Chemical Compositi... <1%

135 Publication
Bioactive Dietary Factors and Plant Extracts in Dermatology, 2013. <1%

136 Student papers
Olabisi Onabanjo University on 2023-10-08 <1%

137 Student papers

Sharda University on 2023-05-23 <1%

138 Publication

Sneh Punia, Anil Kumar Siroha, Manoj Kumar. "Handbook of Cereals, Pulses, Root... <1%

139 Publication

Srinivasan Damodaran, Kirk L. Parkin. "Fennema's Food Chemistry", CRC Press, 20... <1%

140 Publication

Theodora Kalogerakou, Maria Antoniadou. "The Role of Dietary Antioxidants, Foo... <1%

# MILLET NUTRI BOOST BAR: FORMULATION AND EVALUATION OF A NUTRITIONAL HERBAL EBERGY BAR FOR HEALTH AND WELLNESS

## Abstract

The development of a functional food product Millet Nutri Boost Bar created using native grains and plant-based components to meet current nutritional needs while supporting environmental sustainability. The bar is formulated with finger millet along with nutrient-dense ingredients such as dates, almonds, amla and moringa. The primary goal was to produce an energy-rich, health-enhancing snack that excludes refined sugars and artificial additives. Nutritional analysis indicated that the bar is a good source of dietary fiber, protein, and essential vitamins and minerals. Sensory evaluation results showed that the product was well accepted by consumers in terms of taste, texture, and overall quality. The use of locally sourced grains and simple processing methods highlights the product's environmental and economic benefits. Overall, shows promise as a nutritious and eco-friendly snack, contributing to the advancement of clean-label, plant-based functional foods.

**Keywords:** Functional food, sensory evaluation, sustainable nutrition, dietary fiber, protein.

## Table of Content

## List Of Figure

| | | |
|---|---|---|
| 19. | Score of Aroma | 33 |
| 20. | Score of Overall Acceptability | 33 |

## List Of Tables

## Introduction

In today's world, where health awareness is increasing and people are leading busier lives, there is a growing demand for quick, nutrient-rich, and natural food options. Energy bars, especially those meant for on-the-go consumption, have become popular as an easy way to get the energy needed without sacrificing nutrition or flavor. However, while many traditional energy bars are filled with sugars, artificial additives, and synthetic nutrients, a new category of energy bars has emerged to meet the needs of more health-conscious consumers—herbal energy bars. These bars are designed not just to provide lasting energy but also to support overall health by combining traditional medicinal herbs and plants with common nutritional ingredients. As the combination of ancient herbal practices and modern nutrition continues to grow, herbal energy bars are becoming increasingly popular in the health food market, offering a more balanced approach to nutrition and well-being.[1]

Herbal energy bars are based on the idea of functional nutrition, which suggests that food should do more than just satisfy hunger; it should also improve both physical and mental health.[2] Functional foods provide extra health benefits beyond basic nutrition, and herbal energy bars are a good example of this. Unlike regular energy bars that mainly use simple carbs, protein powders, and artificial vitamins, herbal energy bars contain herbs known for their adaptogenic, antioxidant, anti-inflammatory, and immune-boosting effects.[3] The use of herbs in daily diets is not a new concept, as many cultures have included them for both flavor and their healing properties. Traditional medicine systems, like Ayurveda, Traditional Chinese Medicine (TCM), and Western herbalism, have been using plant-based remedies for thousands of years.[4] What sets modern herbal energy bars apart is the careful design that combines these ancient herbs with scientific research, making them suitable for today's health-conscious consumers. Each bar is carefully crafted with a balanced mix of macronutrients—proteins, fats, and

carbs—along with specific herbs that target health benefits such as increased energy, better digestion, improved endurance, and enhanced mental clarity.[5]

When it comes to nutritional content, high-quality herbal energy bars are usually made with whole food ingredients like nuts, seeds, dried fruits, whole grains, and natural sweeteners such as honey or dates. These ingredients provide a rich mix of grenfull and maintain steady energy levels.[6] As people pay closer attention to food labels, there is a noticeable shift toward choosing products without artificial additives and ones that promote overall well-being. With plant-based diets becoming more popular for health and environmental reasons, herbal energy bars are a great option for those following dairy-free, gluten-free, or vegan lifestyles.[7]

Many companies are now focusing on using organic ingredients, sourcing materials ethically, and providing clear labels, which makes these bars more appealing to eco-friendly and health-conscious buyers. A major benefit of herbal energy bars is how versatile they are-they can be used before a workout, as a quick afternoon snack, or even as a meal replacement during a busy day. Unlike traditional snack bars that are often loaded with sugar and cause energy crashes, herbal bars are made to deliver long-lasting energy thanks to their low glycemic index and high nutritional value.[8]

In addition, many of these bars include adaptogenic herbs that help the body handle stress, benefiting not just physical performance but also mental and emotional health. For instance, herbs like amla are high in antioxidants and help protect cells by fighting off harmful free radicals.[9] These herbs often work better when combined, interacting with each other and with the bar’s main ingredients to improve the overall effect.

Creating herbal energy bars involves both scientific knowledge and traditional herbal practices. It’s important to choose herbs that not only go well together in terms of taste but also work well with the other ingredients and are easily absorbed by the body. Food scientists and herbal experts often work together to make sure these bars are effective and still taste good-something that's essential for consumer satisfaction.

Sustainability is another key feature of these products. As environmental concerns grow, more consumers are choosing brands that use environmentally friendly practices. Many herbal bar producers use herbs that are wildcrafted or organically grown, support regenerative farming, and use packaging that can be recycled or composted.[10] This helps protect ecosystems and supports local farmers and

communities, all while reflecting consumer values.

Besides offering physical and mental health benefits, herbal energy bars also help bridge the gap between traditional herbal medicine and today's wellness trends. For people who might find using herbal products like powders or capsules complicated, these bars provide an easy, tasty, and portable way to include herbs in their diets.[11] This makes holistic health practices more accessible and encourages more people to adopt them.

Overall, the growing popularity of herbal energy nutrition bars marks an important step forward in functional foods. These bars successfully combine modern nutritional strategies with ancient herbal knowledge to create products that are convenient, tasty, and health-focused. As more people look for natural ways to improve energy, concentration, stress management, and overall wellness, demand for herbal bars is expected to increase. Whether for athletes, busy professionals, or anyone looking to live a healthier life, herbal energy bars provide a well-rounded, evidence-based option. With a focus on innovation, integrity, and wellness, these bars are more than just a health trend-they represent a shift toward a more balanced and sustainable way of eating.

**Selection of herbal drugs:**

In today's society, individuals are increasingly mindful of their dietary choices and their impact on personal health. With the rising popularity of natural and functional foods, there is a significant demand for nutritious snack options that not only supply energy but also contribute to overall health. This growing interest served as the foundation for the development of a millet-based herbal energy bar designed to go beyond basic nourishment by promoting general wellness.

This product incorporates a combination of herbs and millets-grains known for their high fiber, protein content, and essential nutrients-to create a snack that is both nutritionally comprehensive and functionally advantageous. The primary goal of this energy bar is not merely to provide a convenient energy source, but also to support oral health and holistic well-being through the use of natural components.

The development process involved careful selection of suitable millets and herbal ingredients, as well as the optimization of the product's texture and flavor profile. In addition, the final formulation was evaluated for its nutritional value and shelf stability. Through this innovation, the intention is to deliver a health-oriented snack that draws from traditional herbal practices while being validated by contemporary

nutritional science-a thoughtful integration of ancestral knowledge and modern research.

## 1. Finger Millet

Common names: Ragi
Botanical name: *Eleusine coracana*

*Figure 1: Finger Millet*

Millets are a diverse group of small-seeded cereal crops that have been cultivated for millennia in regions such as India, Asia, and Africa. Recently, they have experienced a resurgence in interest due to their exceptional nutritional qualities and resilience in challenging agricultural conditions. Commonly referred to as "nutri-cereals," millets are inherently gluten-free and possess a low glycemic index, making them particularly suitable for individuals with celiac disease or those managing diabetes [12].

Traditionally, millets have been valued for more than just their energy-yielding potential. They have long been associated with benefits to digestive health, antioxidant capacity, and chronic disease management. Nutritionally, they are rich in dietary fiber, complex carbohydrates, essential amino acids, and a wide range of micronutrients, including B-complex vitamins and minerals such as iron, magnesium, phosphorus, and calcium [13]. These attributes support metabolic functions, enhance gut health, and aid in weight regulation.

Emerging scientific evidence has underscored the functional potential of millets, highlighting the presence of bioactive compounds such as polyphenols and antioxidants. These compounds have been linked to a reduction in oxidative stress and systemic inflammation, which may lower the risk of non-communicable diseases such as cardiovascular disorders, obesity, and type 2 diabetes [14]. Additionally, certain varieties of millets exhibit prebiotic characteristics, contributing to the maintenance of a healthy gut microbiota.

Given these properties, millets are well-suited for use in the development of functional foods, including herbal energy bars. Their nutrient density and structural

properties make them an effective base ingredient, while their mild, nutty flavor profile allows for harmonious blending with herbal components, enhancing both the taste and health value of the final product.

## 2. Amla Powder

*Figure 2: Amla Powder*

Common name: Indian Gooseberry
Botanical name: *Phyllanthus emblica* (syn. *Emblica officinalis*)

Amla (Phyllanthus emblica), commonly referred to as Indian gooseberry, holds a significant place in traditional Ayurvedic medicine, where it is classified as a "Rasayana"-a category of rejuvenating herbs believed to enhance vitality, strengthen immunity, and promote longevity [15]. Amla powder is derived by drying and grinding its small, green, and sour-tasting fruits, which are highly valued for their medicinal and nutritional properties.

One of the most notable characteristics of amla is its exceptionally high Vitamin C content, reportedly containing up to 20 times more than that found in oranges. Unlike synthetic sources, the Vitamin C in amla remains stable even after drying, making it a highly bioavailable and dependable source of this essential micronutrient [16]. In addition to Vitamin C, amla is rich in various bioactive compounds, including polyphenols, flavonoids, tannins, and gallic acid-all of which contribute to its anti-inflammatory, antimicrobial, and antioxidant properties [17].

Scientific research supports the therapeutic potential of amla, indicating its role in promoting collagen synthesis, enhancing digestive health, supporting liver detoxification, and improving the absorption of iron [18]. The fruit's antioxidant capacity is particularly significant in the context of chronic disease prevention, as it helps neutralize oxidative stress and reduce inflammation—both of which are implicated in the pathophysiology of conditions such as cardiovascular disease and diabetes.

In the development of functional food products like herbal energy bars, amla powder contributes both nutritional and functional benefits. Its tangy flavor profile

complements herbal formulations, while its natural preservative qualities can aid in extending product shelf life and maintaining sensory freshness.

## 3. **Moringa Powder**

Common name: Drumstick tree, Munga, Sahjan
Botanical name: *Moringa oleifera*

*Figure 3: Moringa Powder*

Moringa oleifera, commonly known as the "Miracle Tree," has been utilized for centuries in traditional medicine across India, Africa, and Southeast Asia due to its extensive therapeutic and nutritional properties. Among its various parts, the leaves—typically dried and processed into a fine green powder—are considered the most nutritionally dense [19].

Rich in essential nutrients, moringa powder is recognized as a superfood containing significant amounts of protein, calcium, potassium, and iron, along with vital vitamins such as A, C, and E [20]. Furthermore, it contains all nine essential amino acids and is abundant in antioxidants like quercetin and chlorogenic acid, which are known to mitigate oxidative stress and support cellular functions [21].

Research highlights moringa's anti-inflammatory, hypoglycemic, hypocholesterolemic, and antimicrobial effects, suggesting its role in enhancing immune responses, supporting gut health, and regulating metabolic processes [22]. Studies also indicate that moringa supplementation can aid in maintaining blood glucose levels, alleviating inflammation, and potentially reducing the risk of chronic diseases such as cardiovascular disorders and type 2 diabetes [23].

Incorporating moringa powder into a millet-based herbal energy bar not only enhances its nutritional value but also contributes an earthy flavor profile that harmonizes well with both sweet and savory elements. Its vivid green hue and functional health benefits position moringa as a valuable ingredient in wellness-oriented snack formulations aimed at promoting holistic health.

## 4. Sesame Seeds

*Figure 4: Sesame Seeds*

Common names: Til (Hindi), Gingelly, SimSim
Botanical name: *Sesamum indicum*

Sesame seeds (*Sesamum indicum*) are among the oldest cultivated oilseed crops, traditionally valued not only for their culinary applications but also for their role in medicinal practices throughout Asia, Africa, and the Middle East [24]. Despite their small size, sesame seeds are dense in nutrients and contribute significantly to human health when incorporated into the diet.

Nutritionally, sesame seeds are a rich source of healthy fats-particularly omega-6 and other polyunsaturated fatty acids-as well as protein, dietary fiber, and essential minerals such as calcium, magnesium, phosphorus, zinc, and iron [25]. These nutrients are known to support bone density, digestive efficiency, and long-lasting energy. In addition, sesame seeds provide a substantial amount of B-complex vitamins, particularly thiamin (B1) and niacin (B3), both of which are involved in metabolic pathways for energy production [26].

What distinguishes sesame seeds from other oilseeds is their unusually high content of lignans, especially sesamin and sesamolin. These phytochemicals exhibit potent antioxidant and anti-inflammatory properties and have been linked to improved cardiovascular health through mechanisms such as cholesterol reduction, blood pressure regulation, and hepatoprotection [27].

In the context of functional food development-such as millet-based herbal energy bars-sesame seeds contribute both nutritional and sensory value. They impart a pleasant crunch and a natural nutty flavor, while their lipid profile enhances the bioavailability of fat-soluble vitamins and phytonutrients present in other ingredients. This multifunctional role makes sesame seeds an ideal component in snacks designed for health-conscious consumers.

## 5. Jaggery

Common names: Gud, Bellam, Vellam
Source: Traditional unrefined sugar made from sugarcane juice or palm sap.

*Figure 5: Jaggery*

Jaggery, a traditional, unrefined sweetener derived primarily from sugarcane or palm sap, is widely used throughout India and other South Asian countries. Unlike refined sugar, which undergoes extensive processing and chemical treatment, jaggery retains many of the natural minerals and phytochemicals present in its raw plant sources, rendering it not only a sweetening agent but also a functional food component [28].

From a nutritional perspective, jaggery is a noteworthy source of iron, magnesium, potassium, and calcium-micronutrients essential for maintaining electrolyte balance, promoting bone strength, and supporting hematological health, particularly in the prevention of iron-deficiency anemia[29]. It also provides trace amounts of B-complex vitamins and polyphenolic compounds with antioxidant properties that have been associated with liver detoxification, improved digestion, and enhanced metabolic function [30].

Traditionally used in Ayurvedic and folk medicine as a digestive aid and natural energizer, jaggery is known to promote thermogenesis and provide sustained energy release. Its robust, molasses-like flavor adds sensory richness to food products, harmonizing particularly well with the earthy, wholesome profiles of herbs, seeds, and millets commonly found in functional health foods [31].

In the formulation of millet-based herbal energy bars, jaggery fulfills several functional roles. It acts as a natural sweetener and flavor enhancer while also serving as a binding agent that contributes to the structural integrity of the bar. Moreover, its nutrient density adds to the product's overall health appeal, making it a culturally resonant and nutritionally advantageous alternative to refined sugars in wellness-focused food applications.

## 6. Dates

Common names: Khajoor, Tamar, Kharek
Botanical name: *Phoenix dactylifera*


*Figure 6: Dates*

Dates (*Phoenix dactylifera*), the sweet fruits of the date palm tree, have been revered for centuries in Middle Eastern and South Asian cultures for their nutritive value and natural sweetness. Often dubbed "nature's candy," dates present a wholesome, nutrient-rich alternative to refined sugars and are increasingly used in health-conscious food formulations [32].

Nutritionally, dates are abundant in natural sugars such as glucose, fructose, and sucrose, as well as complex carbohydrates that provide a rapid yet sustained source of energy [33]. They are also a rich source of dietary fiber and essential micronutrients, including potassium, magnesium, copper, iron, and phosphorus. Additionally, dates contain significant levels of B-complex vitamins, particularly niacin (B3) and pyridoxine (B6), both of which play critical roles in energy metabolism and neural function [34].

Dates also exhibit potent antioxidant activity, owing to their concentration of flavonoids, carotenoids, and phenolic acids. These bioactive compounds contribute to the fruit's anti-inflammatory properties and its potential role in reducing oxidative stress and supporting overall health [35]. Their high fiber content further promotes digestive health, supports gut microbiota, and enhances satiety-making dates valuable in the development of functional food products aimed at digestive wellness and weight management.

In millet-based herbal energy bars, dates serve multiple functional purposes. They act as a natural sweetener and a binder, providing cohesive texture while eliminating the need for refined sugars or synthetic additives. Their chewy consistency enhances mouthfeel, and their nutrient density improves the overall health profile of the product, making dates an integral component in the creation of clean-label, energy-boosting snacks.

## 7. Groundnuts

Common names: Peanut, Moongphali, Verkadalai
Botanical name: *Arachis hypogaea*

*Figure 7: Groundnuts*

Groundnuts (*Arachis hypogaea*), more commonly known as peanuts, are widely cultivated legumes that serve as both a staple food and a highly nutritious snack in many parts of the world, including India. Far beyond their popularity as a snack, groundnuts are a rich source of plant-based protein, beneficial fats, and vital micronutrients, making them a valuable component in both traditional diets and modern functional foods [36].

Peanuts are particularly high in monounsaturated and polyunsaturated fatty acids, which are known for their cardioprotective effects, including the regulation of serum cholesterol levels [37]. In addition to healthy fats, groundnuts provide significant amounts of vitamin E, niacin (vitamin B3), folate, magnesium, and zinc. They are also a notable source of arginine, an amino acid involved in immune modulation and vascular function [39].

The health benefits of groundnuts extend beyond their macronutrient content. They are rich in antioxidants such as resveratrol and other polyphenolic compounds, which have been associated with anti-inflammatory, antioxidant, and neuroprotective properties [40]. Due to their substantial protein and fat content, peanuts also provide a sustained energy release, supporting both satiety and metabolic stability—attributes that are particularly valuable in energy-dense functional foods.

In millet-based herbal energy bar formulations, groundnuts play a multifunctional role. They contribute a savory, nutty flavor and a desirable crunchy texture, while acting as a plant-based protein source and a satiety-promoting ingredient. The presence of healthy lipids further aids in the absorption of fat-soluble vitamins and phytochemicals from herbs and other ingredients. Whether incorporated in roasted, crushed, or ground form, peanuts enhance the sensory appeal and nutritional profile of energy bars designed for wellness-focused consumers.

## 8. Ragi Flour

Common names: Finger millet, Nachni, Kezhvaragu
Botanical name: *Eleusine coracana*

*Figure 8 : Ragi Flour*

Ragi (*Eleusine coracana*), commonly referred to as finger millet, is an ancient cereal crop widely cultivated in the arid and semi-arid regions of India and sub-Saharan Africa. Celebrated for its climate resilience and low-input requirements, ragi is also recognized as a highly nutritious grain, particularly in its milled flour form [40].

Nutritionally, ragi flour is naturally gluten-free and rich in dietary fiber, making it suitable for individuals with gluten sensitivities. It is an excellent plant-based source of calcium-often cited as one of the richest non-dairy sources-along with other vital micronutrients such as iron, magnesium, and phosphorus. Additionally, it contains essential amino acids like methionine, which are often limited in other cereal grains [41,42].

A key functional benefit of ragi lies in its low glycemic index, which contributes to better blood sugar regulation and makes it a recommended grain for diabetic and weight-conscious populations. Its high fiber content not only improves digestive efficiency but also supports gut health and enhances satiety, thereby aiding in appetite control and metabolic balance [43].

In the context of functional food development—such as millet-based herbal energy bars—ragi flour offers multiple advantages. It provides a nutritionally dense base that contributes to texture, softness, and mouthfeel. Ragi pairs synergistically with natural sweeteners like jaggery and dates, and complements herbal and seed-based components both in flavor and functionality. Its traditional roots, combined with modern nutritional relevance, make it an ideal ingredient for health-oriented food products aimed at diverse consumer groups, including children, athletes, and health-conscious individuals.

## 9. Bajra Flakes

Common names: Pearl millet flakes, Bajra Poha
Botanical name: *Pennisetum glaucum*

Bajra flakes, derived from *Pennisetum glaucum* (pearl millet), represent a nutritionally valuable and versatile ingredient that originates from one of the most ancient and resilient millet varieties cultivated in India and sub-Saharan Africa. Known for its drought tolerance and minimal input requirements, pearl millet has gained recognition not only for its environmental adaptability but also for its significant health benefits [44].

*Figure 9: Bajra Flakes*

When processed into flakes-similar to the traditional method of flattening rice to make *poha*-bajra becomes a convenient and shelf-stable base for a variety of functional foods, including energy bars. These flakes are naturally gluten-free and are an abundant source of complex carbohydrates, dietary fiber, and essential micronutrients such as iron, magnesium, phosphorus, zinc, and B-complex vitamins [45]. The high iron content, in particular, supports hemoglobin production and helps prevent iron-deficiency anemia, making it beneficial for vulnerable groups such as women and children [46].

Bajra flakes also contain bioactive phytochemicals and polyphenolic compounds known for their antioxidant, anti-inflammatory, and cardioprotective effects. These compounds contribute to the grain's potential in managing metabolic disorders such as diabetes and cardiovascular disease [14]. Moreover, their high fiber content plays a crucial role in digestive health, enhances satiety, and aids in maintaining glycemic control-characteristics essential for individuals aiming to manage body weight or prevent blood sugar spikes.

In the development of millet-based herbal energy bars, bajra flakes provide multiple functional advantages. They contribute a light, crispy texture and serve as a nutrient-dense whole grain base. Their mild flavor profile allows them to pair effectively with both sweet and savory herbal ingredients, enhancing the sensory appeal and nutritional profile of the product. Furthermore, their complex carbohydrate matrix supports sustained energy release, making them suitable for a broad consumer base including athletes, school-aged children, and working professionals seeking clean-label, plant-based nourishment.



## 10.Ragi Flakes

Common names: Finger millet flakes, Nachni flakes, Kezhvaragu aval
Botanical name: *Eleusine coracana*

*Figure 10: Ragi Flakes*

Ragi flakes, produced by flattening the grains of *Eleusine coracana* (finger millet), offer a convenient and nutritionally robust form of this ancient cereal. Retaining all the key benefits of finger millet, ragi flakes are easier to prepare and digest, making them especially suitable for inclusion in health-oriented, ready-to-eat formulations such as energy bars [45].

Like ragi flour, these flakes are inherently gluten-free and rich in dietary fiber, calcium, iron, and essential amino acids, particularly methionine and tryptophan—nutrients that are often deficient in common cereal grains. These components contribute significantly to bone development, muscle function, and immune health, especially in nutritionally vulnerable populations [42,43].

Importantly, ragi flakes have a low glycemic index, meaning they help maintain steady blood glucose levels and support sustained energy release. This property makes them ideal for individuals with diabetes or those aiming to regulate energy and appetite. Their high fiber content aids digestive health, improves gut motility, and enhances satiety, all of which are desirable characteristics in functional foods designed for metabolic balance [47].

When integrated into millet-based herbal energy bars, ragi flakes serve multiple purposes. They contribute a crisp texture and enhance the overall nutritional profile with calcium, iron, and amino acids. Their lightness improves digestibility, while their neutral, earthy flavor pairs harmoniously with herbs, seeds, and natural sweeteners like jaggery and dates. Furthermore, ragi flakes support the development of targeted nutrition solutions for groups such as children, women, athletes, and the elderly, due to their balanced composition and functional appeal.

## 11.Ghee

Common names: Clarified butter, Desi ghee
Source: Traditional Indian clarified butter made by

simmering butter to remove water content and milk solids

Ghee, a clarified form of butter, holds a central place in both traditional Indian culinary practices and Ayurvedic medicine. Produced by gently heating butter to remove water and milk solids, ghee is composed almost entirely of pure fat and is free from lactose and casein, making it generally suitable for individuals with dairy sensitivities[48].Nutritionally, ghee is rich in saturated fats, including short-chain fatty acids like butyric acid (butyrate), which has been shown to support gut integrity, reduce inflammation, and serve as a vital energy source for colon cells [49]. Ghee also provides essential fat-soluble vitamins-A, D, E, and K-that contribute to immune function, skeletal development, vision, and skin regeneration [50]. These nutrients are more bioavailable in the lipid matrix of ghee, enhancing their absorption when consumed with other fat-soluble compounds.

*Figure 11: Ghee*

In Ayurvedic tradition, ghee is classified as a *rasayana*, or rejuvenating substance, believed to nourish body tissues (*dhatus*), promote digestive efficiency (*agni*), and support cognitive functions such as memory and clarity. Contemporary research supports its use as a carrier fat that enhances the delivery and bioavailability of herbs and phytonutrients in functional foods [51].

When incorporated into millet-based herbal energy bars, ghee offers several functional advantages: Serves as a natural binder and softener, improving the bar's texture, enhances the bioefficacy of fat-soluble vitamins and herbal extracts, provides a rich, nutty aroma and smooth mouthfeel, delivers long-lasting energy through its high-quality fat composition.

Moreover, ghee's high smoke point and oxidative stability make it an ideal fat for shelf-stable snack products, contributing to both safety and sensory quality over time [52].

## 12.Dark Compound

Common names: Compound chocolate, Cocoa compound

Composition: A blend of cocoa solids, vegetable fat (instead of cocoa butter), and sugar.

Dark compound chocolate is a widely used chocolate substitute in both industrial and domestic settings, particularly in functional food applications where affordability, ease of processing, and product stability are essential. Unlike traditional couverture chocolate, which relies on cocoa butter, dark compound chocolate substitutes this with vegetable fats such as palm kernel or hydrogenated oils. This substitution increases its heat resistance and eliminates the need for tempering, making it well-suited for coating and binding in energy bar formulations [53,54].

*Figure 12: Dark Compound*

Although it lacks the full nutrient profile of pure chocolate, dark compound retains cocoa solids, which are known to be rich in flavonoids and other polyphenolic compounds. These bioactive constituents have been associated with cardiovascular benefits, anti-inflammatory activity, and enhanced cognitive performance [55,56]. Cocoa's natural mood-enhancing effects are also well-documented, largely due to its impact on serotonin and endorphin levels, making it an attractive ingredient in health-conscious snack development [57].

When incorporated into millet-based herbal energy bars, dark compound chocolate offers multiple advantages: Enhances sensory appeal through its rich cocoa flavor and smooth texture, delivers polyphenol-based antioxidant benefits, acts as a practical coating or internal binder, supports palatability in formulations containing herbs, seeds, or whole grains, improves structural integrity by binding dry ingredients.

While it does not match the health benefits of high-percentage dark couverture chocolate, dark compound chocolate remains a cost-effective and widely accepted option for developing nutritious snacks with broader market appeal, especially in regions with limited access to premium ingredients [58].

## 13.Milk Powder

Common names: Dried milk, Dairy powder

Source: Dehydrated form of pasteurized cow's milk

Milk powder is a commonly used dairy ingredient created by evaporating milk to remove its water content, leaving behind a dry powder that retains much of the nutritional value of fresh milk. As a shelf-stable ingredient, it offers convenience without compromising its health benefits, making it an ideal addition to various functional food products [60].

*Figure 13: Milk Powder*

Milk powder is a rich source of high-quality animal protein, which includes both casein and whey proteins, making it a complete protein that provides all essential amino acids necessary for human health [59]. Additionally, it is packed with key minerals such as calcium, phosphorus, and potassium, which are vital for bone health, muscle function, and nerve transmission. Milk powder is also a significant source of B vitamins, particularly riboflavin (B2), vitamin B12, and vitamin D, which support energy metabolism, immune function, and calcium absorption [61].

In the context of millet-based herbal energy bars, milk powder offers multiple functional benefits: Enhances the nutritional profile, particularly in protein and calcium content, improves the texture and creaminess of the bar, contributing to a desirable mouthfeel, adds a mild, creamy flavor that complements other ingredients such as herbs, grains, and natural sweeteners, acts as a binder, helping to maintain the bar's shape and consistency.

For individuals seeking to improve their nutritional intake—whether children, athletes, or the elderly—milk powder provides a convenient and enjoyable way to meet essential dietary needs in energy bar formulations [61].

## 14.Almond

Common names: Badam, Ground almonds
Botanical name: *Prunus dulcis*

*Figure 14: Almond*

Almond powder, produced by finely grinding raw or blanched almonds, is a highly nutritious ingredient commonly used in health-focused foods. Widely

celebrated for its presence in both traditional Indian and Mediterranean diets, almonds are often regarded as a "superfood nut" due to their exceptional nutritional profile [64].

Almond powder is naturally gluten-free and provides a rich source of monounsaturated fats, plant-based proteins, vitamins, and essential minerals. It is particularly high in vitamin E, a potent antioxidant that plays a crucial role in protecting cells from oxidative damage. Almond powder also offers magnesium, calcium, fiber, potassium, and additional antioxidants that contribute to heart health, bone strength, and skin repair [62]. The presence of healthy fats and fiber aids in promoting satiety, regulating blood sugar levels, and improving cholesterol profiles, making almond powder an excellent choice for functional food formulations [61].

In millet-based herbal energy bars, almond powder offers several functional advantages: Increases the nutritional value, particularly in terms of protein and healthy fats, provides a naturally sweet, nutty flavor that complements the taste of herbs and grains, contributes to a moist, soft texture that enhances the mouthfeel of the bar, supports sustained energy release, brain function, and skin health.

Given its versatile nutritional profile and plant-based origin, almond powder serves as a valuable ingredient in energy bars aimed at consumers seeking nutrient-dense and wholesome foods [63].

## Aim and Objective

### Aim

The primary objective of this research is to formulate and assess a functional herbal nutritional energy bar enriched with traditional medicinal herbs, nutrient-rich millets, natural sweeteners, and plant-derived ingredients. The goal is to create a health-promoting snack that supports sustained energy release, metabolic function, and overall wellness. The developed product is designed to cater to the nutritional demands of various population groups, including children, health-conscious individuals, and those seeking wholesome alternatives to conventional snack foods.

### Objective

1. Develop a millet-based herbal energy bar with balanced nutrition.
2. To Explore cost-effective method for formulation of Millet based herbal energy bar.
3. Enhance nutrient profile using energy-rich, plant-based ingredients.
4. Analyze bar composition for nutrients, calories, and minerals.

5. Promote use of native, sustainable food ingredients.

6. Evaluate the role of each ingredient in the formulation.

## Plan of Work

1. **Literature Review:** Conduct an in-depth review of existing research related to the nutritional composition and health benefits of millets, traditional medicinal herbs, and functional food products to establish a scientific foundation for the formulation.

2. **Selection of Ingredients**: Identify and select suitable millet types, herbal components, and other complementary ingredients based on their established nutritional value and functional roles in promoting health and wellness.

3. **Product Formulation and Development:** Design and optimize the formulation of the millet-based herbal nutritional bar through iterative trials, focusing on achieving a balance between nutrition, texture, flavor, and stability.

4. **Sensory Analysis:** Perform organoleptic evaluations-including assessments of taste, texture, aroma, appearance, and overall acceptability-using structured sensory panels to ensure consumer satisfaction and preference.

5. **Nutritional Analysis:** Perform nutritional analysis including fat, carbohydrates, energy value, protein, cholesterol, etc..

6. **Data Compilation and Reporting:** Document experimental findings, compile nutritional and sensory data, and prepare a comprehensive report that outlines the formulation process, key outcomes, and potential applications for large-scale or commercial production.

## Materials and Methods

### Procurement of Materials

The raw materials utilized for formulating the millet-based herbal nutritional energy bar were sourced from reputable and standardized vendors to maintain the quality, safety, and authenticity of the ingredients. Selection of all components was guided by their established functional, nutritional, and sensory characteristics, as identified through an extensive literature review and the ingredient selection process.

### 1. Primary Ingredients

*Table 1: Primary Ingredients*

| Ingredient | Source | Specification/Grade |
|---|---|---|
| Ragi (Finger millet) flour | Local organic grain store / certified supplier | Cleaned, milled, food-grade |
| Bajra (Pearl millet) flakes | Health food outlet / millet promotion center | Dehulled, pre-flaked, food-grade |
| Dates | Dry fruit wholesaler | Deseeded, soft, naturally |

| | | |
|---|---|---|
| | | sweet |
| Jaggery | Local market | Unrefined, chemical-free |
| Ghee | Dairy or Ayurveda-based store | Cow ghee, traditionally prepared |
| Milk powder | Local supermarket | Skimmed milk powder, ISI-marked |
| Almond | Dry fruit store | Blanched |
| Dark compound chocolate | Baking supplies store | Cocoa solids >35%, food-grade |

## 2. Herbal Ingredients

*Table 2: Herbal Ingredients*

| Herbal Component | Source | Specification/Grade |
|---|---|---|
| Moringa (Moringa oleifera) powder | Certified herbal supplier | Dried leaf powder, lab-tested |
| Amla (*Phyllanthus emblica)* powder | Certified herbal supplier | Dried fruit powder, lab-tested |

## 3. Packaging Materials

- Food-grade butter paper or cling wrap
- Zip-lock pouches or vacuum-sealed packaging
- Labeling materials

## 4. Storage of Ingredients

All ingredients were stored in airtight containers in a cool, dry place to prevent moisture absorption, rancidity (for fats), and insect infestation. Perishables like ghee and chocolate were stored under refrigeration if necessary.

## Proximate composition of nutri bar

Raw materials such amla powder, moringa powder, millet flour, bajra flakes, ragi flakes and dates andnutri bar were analysed for proximate composition including moisture, fat, protein, total carbohydrate, crude fiber and mineral composition was carried out as per the methods given by AOAC, 2005[65].

## Formulation of Herbal Nutritional Energy Bar

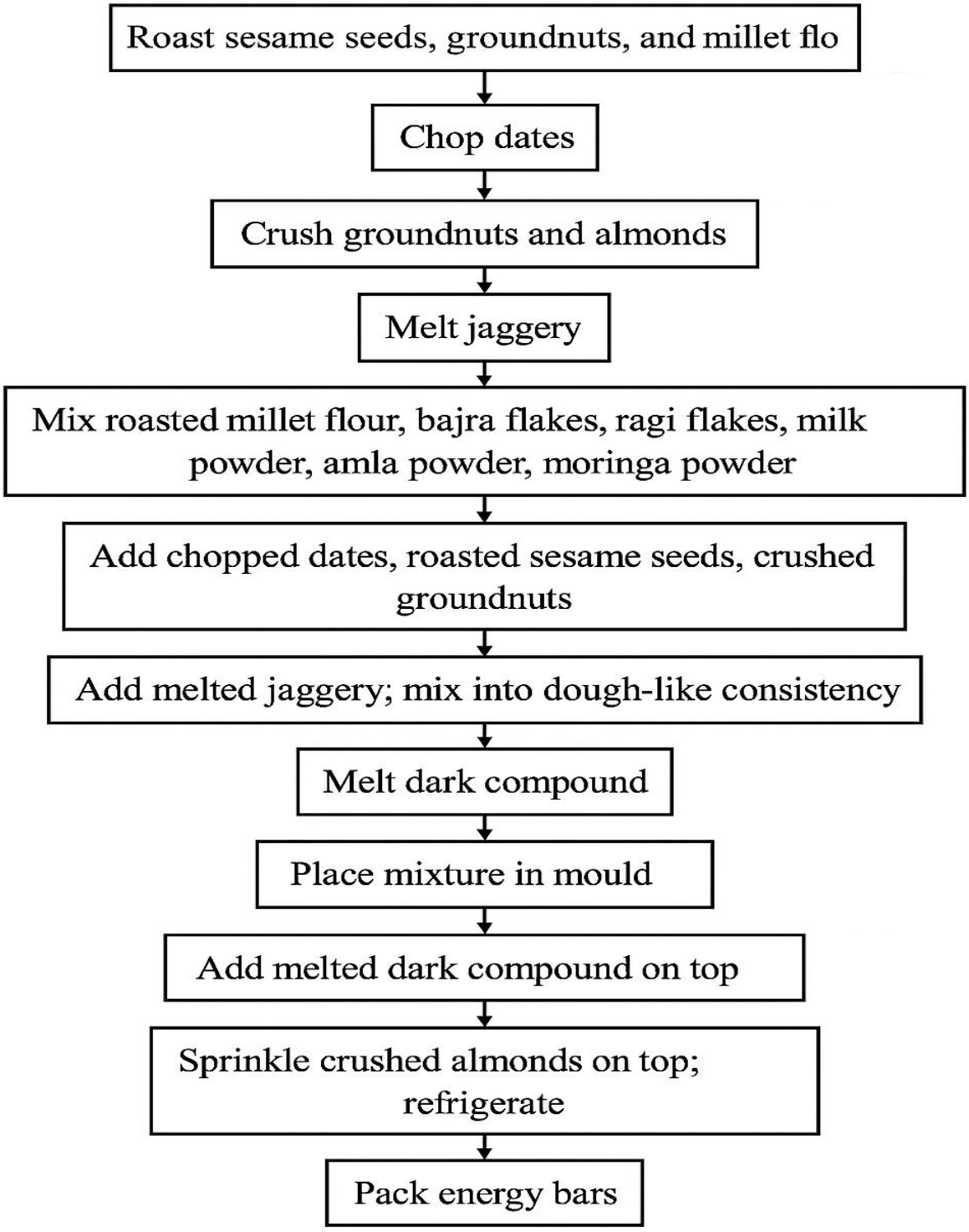
Three different samples of Herbal Energy Bar were prepared by addition of such amla powder, moringa powder, millet flour, bajra flakes, ragi flakes and dates.

*Table 3: Formulation of Herbal Nutritional Energy Bar*

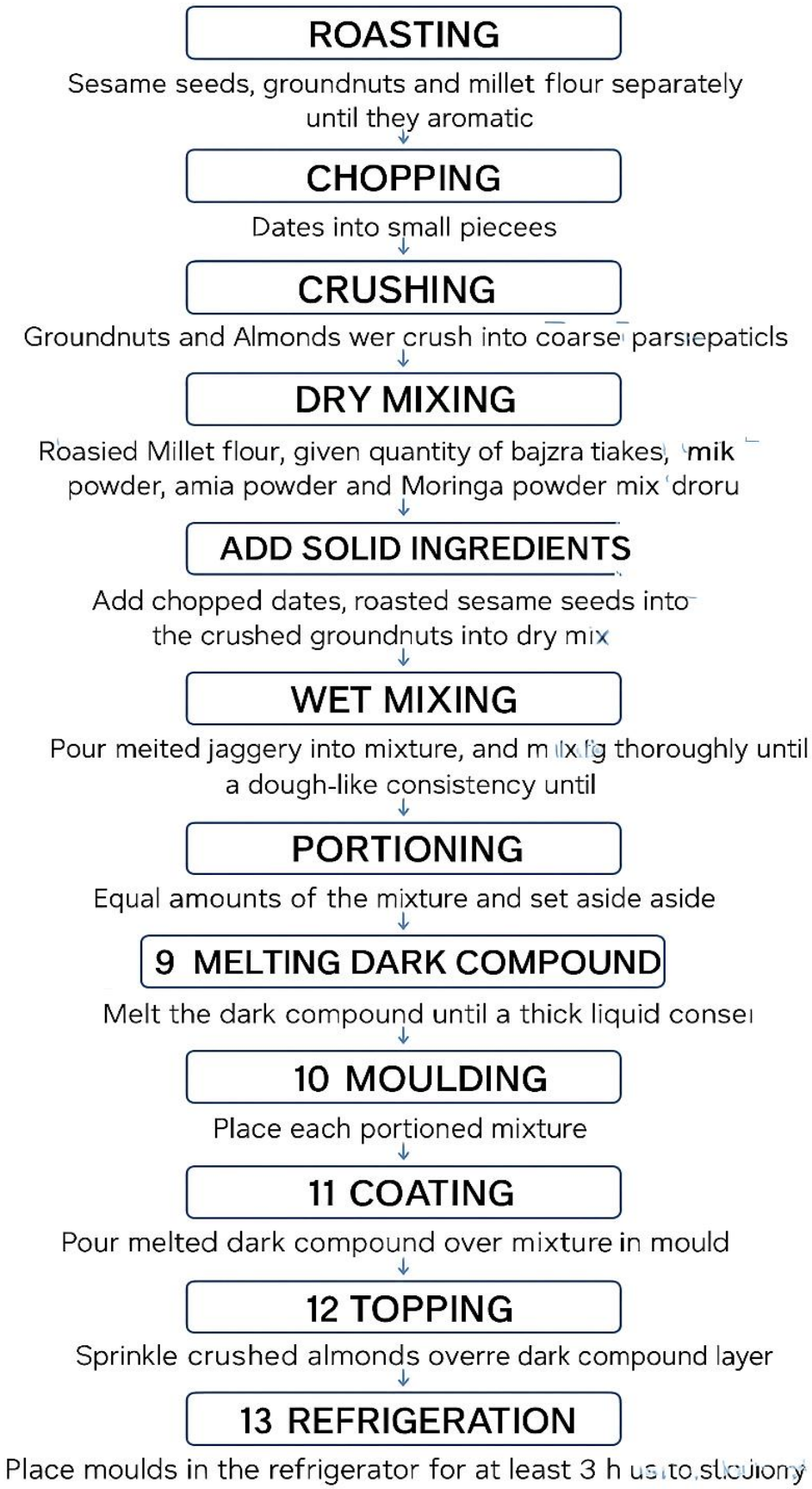
| Ingredients | Sample Combination taken in Grams(gm) | | |
|---|---|---|---|
| | A-1 | A-2 | A-3 |
| Amla powder | 1 | 1 | 1 |
| Moringa powder | 1 | 1 | 1 |
| Sesame seeds | 2 | 3 | 4 |
| Jaggery | 6 | 8 | 10 |
| Dates | 12 | 10 | 8 |
| Groundnuts | 8 | 7 | 6 |
| Millet Flour (Ragi) | 6 | 5 | 4 |
| Milk powder | 1 | 2 | 3 |
| Bajra Flakes | 6 | 6 | 6 |

| | | | |
|---|---|---|---|
| Ragi flakes | **5** | **5** | **5** |
| Ghee | **2** | **2** | **2** |
| Dark compound (CO D15) | **40** | **40** | **40** |
| Almond | **10** | **10** | **10** |

## Methodology



706


ROASTING
Sesame seeds, groundnuts and millet flour separately until they aromatic
CHOPPING
Dates into small piecees
CRUSHING
Groundnuts and Almonds wer crush into coarse parsiepaticls
DRY MIXING
Roasied Millet flour, given quantity of bajzra tiakes, mik powder, amia powder and Moringa powder mix droru
ADD SOLID INGREDIENTS
Add chopped dates, roasted sesame seeds into the crushed groundnuts into dry mix
WET MIXING
Pour meited jaggery into mixture, and mixing thoroughly until a dough-like consistency until
PORTIONING
Equal amounts of the mixture and set aside aside
9 MELTING DARK COMPOUND
Melt the dark compound until a thick liquid consei
10 MOULDING
Place each portioned mixture
11 COATING
Pour melted dark compound over mixture in mould
12 TOPPING
Sprinkle crushed almonds overre dark compound layer
13 REFRIGERATION
Place moulds in the refrigerator for at least 3 h

# Evaluation And Method

## Sensory Evaluation

Sensory evaluation is a systematic approach used to gather, assess, and interpret human responses to food products through the senses of sight, smell, touch, taste, and sound [66]. For functional foods like herbal nutritional energy bars, this process is essential in evaluating consumer preference and predicting the product's potential success in the market.

Purpose of Sensory Evaluation: The main purpose of performing a sensory evaluation on the formulated millet-based herbal energy bar is to examine its sensory characteristics, such as:

- Appearance
- Color
- Texture or mouthfeel
- Flavor or taste
- Smell or aroma
- General consumer acceptance

These factors are crucial in evaluating how well the product aligns with consumer preferences and satisfaction [67].

## Methodology

Panel Selection

A semi-trained sensory panel comprising 10 to 15 participants, aged between 18 and 30 years, was selected from the institution. All panelists were assessed a google form for normal sensory function and provided with basic guidance on the evaluation process.

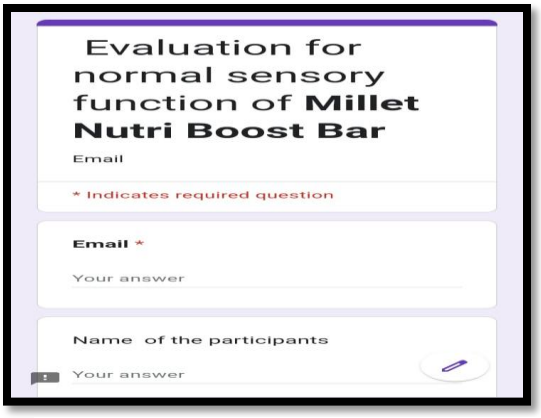



*Figure 15 : Google Form of Evaluation for Sensory Function*

### Evaluation Method

Sensory attributes were assessed using the 9-point Hedonic Scale, where:

- 9 = Like extremely
- 5 = Neither like nor dislike
- 1 = Dislike extremely

Each panelist conducted the evaluation independently under standardized conditions of lighting and temperature to minimize any external influence or bias.

### Sample Preparation

The energy bar samples were freshly made and cut into uniform, bite-sized portions. Each sample was assigned a unique three-digit code and presented in random order to prevent positional bias during the assessment.

### Attributes Assessed

1. **Appearance**
   The visual appeal, including color uniformity, glossiness (due to the chocolate layer), and distribution of herbs and nuts.
2. **Texture**
   Assessed for chewiness, crispness, and cohesiveness.
3. **Taste**
   Overall flavor perception, including sweetness from dates and jaggery, bitterness or herbal notes from moringa/amla.
4. **Aroma**
   The smell contributed by roasted ingredients, herbs, and chocolate. A pleasant and appetizing aroma enhances perceived quality.
5. **Overall Acceptability**
   An overall judgment of the product based on a combination of all sensory attributes.

### Data Analysis

The scores obtained were statistically analyzed using mean and standard deviation, and ANOVA (Analysis of Variance) was applied to identify significant differences between variations. A mean score above 7 was considered acceptable in terms of

consumer preference.

*Table 4: Data Analysis of Sensory Evaluation*

| Attribute | Mean Score (out of 9) | Interpretation |
|---|---|---|
| Appearance | 9.0 | Highly liked |
| Texture | 8.5 | Well accepted |
| Taste | 8.5 | Well accepted |
| Aroma | 8.1 | Highly Accepted |
| Overall Acceptability | 8.5 | Well accepted |

These results suggest that the herbal nutritional energy bar was well received in terms of organoleptic quality, with no major negative feedback reported by panelists.

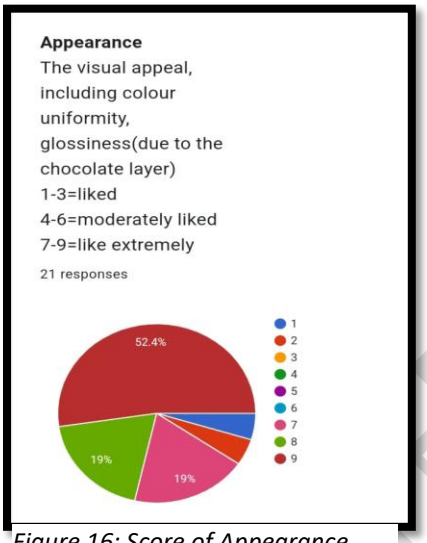



*Figure 16: Score of Appearance*

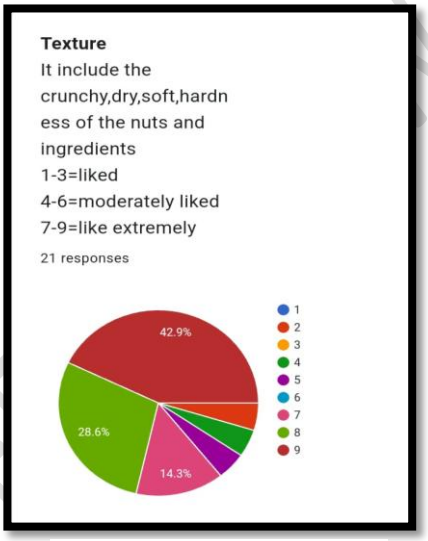



*Figure 17: Score of Texture*

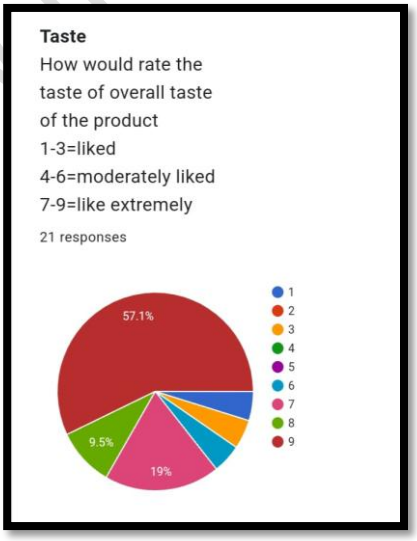



*Figure 16: Score of Taste*

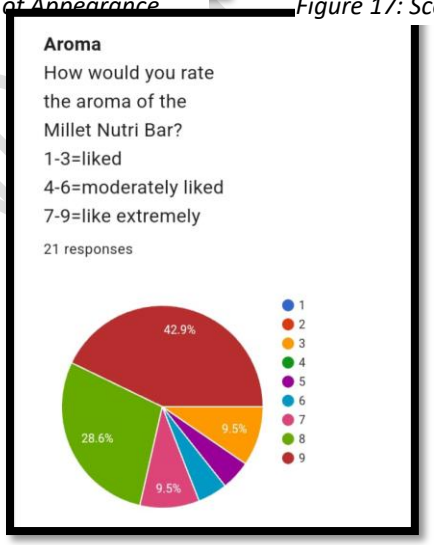



*Figure 19: Score of Aroma*

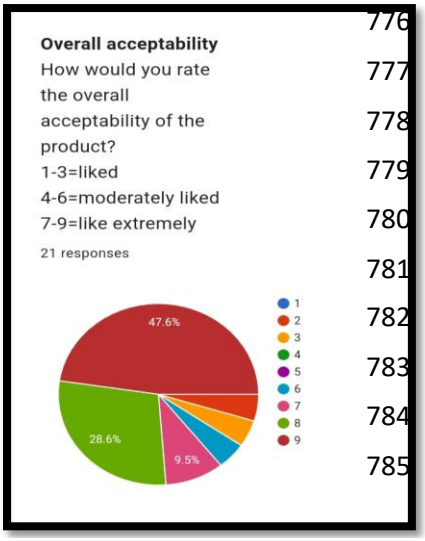



*Figure 20: Score of Overall Acceptability*

## Nutritional Evaluation

The nutritional assess

ment of the developed herbal energy bar plays a vital role in determining its effectiveness as a functional food. It offers valuable information regarding its macro- and micronutrient composition, caloric value, and potential contributions to overall health and well-being.

*Table 5: Data Analysis of Nutritional Evaluation*

| Sr. No. | Name of Parameter | Test Method | Instrument Name |
|---|---|---|---|
| 1. | Fat | IS 15271: 2003 | Soxhlet |
| 2. | Saturated fat, Unsaturated Fat, Monounsaturated Fat, Polyunsaturated Fat, Trans fat | IS 548 (Part 3/Sec 1) : 2021 | Gas Chromatography |
| 3. | Protein (N*6.25) | IS 7219 :1973 | Gerhardt Nitrogen Distillation |
| 4. | Carbohydrate | IS 1656 :2022 | By Calculation |
| 5. | Total Sugar, Sugar as Sucrose | IS 1656 :2022 | By Titration |
| 6. | Sodium | VAL/MOA/0018 | Flame Photometer |
| 7. | Cholesterol | AOAC 22nd Edition: 2023 | Gas Chromatography |
| 8. | Energy | VAL/SOP/0017 | By Calculation |

**Parameter**

**1. Fat**

**Objective**

To estimate the crude fat content present in the developed herbal nutritional energy bar through the Soxhlet extraction technique, which facilitates the continuous extraction of lipids from a pre-weighed sample using a suitable organic solvent, allowing for precise quantification of the total fat content.

**Scope**

The purpose of this analysis is to accurately measure the crude fat content in the formulated herbal nutritional energy bar by employing the Soxhlet extraction technique. This method involves the continuous extraction of lipids from a known quantity of sample using a suitable organic solvent under standardized conditions. It enables the precise estimation of total fat, which is crucial for assessing the nutritional quality and caloric contribution of the product. This evaluation aids in the complete nutritional characterization of the energy bar, supporting its potential classification as a functional food. Furthermore, the Soxhlet method ensures consistency, accuracy, and reliability in lipid determination.

**Principle**

The Soxhlet extraction technique is based on the principle of continuous solvent extraction, where a suitable organic solvent is repeatedly distilled and condensed to dissolve the lipid components from a finely ground, solid sample. The sample is placed in a porous thimble within the extraction chamber, and as the solvent is boiled, it vaporizes, travels through a distillation arm, and condenses into the chamber containing the sample. Once the chamber fills to a certain level, the solvent containing dissolved fats siphons back into the boiling flask, leaving the extracted components behind. This cycle continues for several hours, allowing exhaustive extraction of crude fat. The remaining solvent is evaporated, and the fat content is determined gravimetrically by weighing the residue[68].

The Soxhlet method is widely regarded for its accuracy, repeatability, and applicability to a wide range of food matrices. It remains a gold standard for fat analysis, especially when precise quantification is required for nutritional labeling, research, and quality control. Although newer techniques like supercritical fluid extraction offer faster processing times, Soxhlet extraction is still valued for its simplicity, reliability, and cost-effectiveness in academic and food industry laboratories[69].

**Methodology**

The Soxhlet extraction method was employed to determine the crude fat content in the formulated herbal nutritional energy bar. The procedure was carried out as follows:

1. **Sample Preparation:**

A known quantity (approximately 2–5 grams) of the finely ground energy bar sample was accurately weighed and placed into a porous thimble made of filter paper.

2. **Assembly of the Apparatus:**
The thimble containing the sample was inserted into the main chamber of the Soxhlet extractor. A clean, dry round-bottom flask was connected to the extractor and filled with an appropriate solvent, typically petroleum ether or hexane.
3. **Extraction Process:**
The apparatus was set up with a condenser on top to prevent solvent loss. The solvent was heated in the flask to its boiling point. Vaporstraveled up into the condenser where they cooled and dripped into the extraction chamber, soaking the sample. When the solvent level reached the siphon arm, it automatically drained back into the boiling flask, carrying the dissolved fats.
4. **Duration:**
The extraction cycle was allowed to continue for about 6–8 hours or until complete extraction was ensured, typically indicated by the solvent returning clear after each siphoning.
5. **Post-Extraction:**
After completion, the solvent was evaporated, and the extracted fat residue remained in the round-bottom flask. The flask was dried in an oven at 100–105°C for a short period to remove any remaining solvent.
6. **Weighing and Calculation:**
The flask containing the extracted fat was cooled in a desiccator and then weighed. The crude fat content was calculated by the difference in the flask's weight before and after extraction.

Calculation

$$\text{Fat}(\%) = \frac{\text{Weight of extracted fat}}{\text{weight of sample}} \times 100$$

## 2. Saturated fat, Unsaturated Fat, Monounsaturated Fat, Polyunsaturated Fat, Trans fat

### Objective

The objective of this analysis is to determine the content of saturated fat, unsaturated fat, monounsaturated fat (MUFA), polyunsaturated fat (PUFA), and trans fat in the formulated herbal nutritional energy bar. This evaluation helps assess the quality and healthfulness of the fat composition. Special focus is placed on ensuring a higher proportion of beneficial unsaturated fats and minimizing trans fats. The results will contribute to the nutritional profiling of the product and support health claims related to cardiovascular and metabolic wellness.

### Scope

The scope of this analysis is to accurately quantify the levels of saturated fat, unsaturated fat, monounsaturated fat (MUFA), polyunsaturated fat (PUFA), and trans fat present in the formulated herbal nutritional energy bar. Understanding the fat profile is essential for evaluating the health impact and functional quality of the product. The focus is to ensure that the energy bar provides healthy fats that support heart health while minimizing harmful trans fats.

### Principle

The principle of gas chromatography (GC) for the analysis of saturated fats, unsaturated fats, monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA), and trans fats is based on the separation of fatty acid methyl esters (FAMEs) according to their volatility and interaction with the stationary phase of the chromatographic column. In this method, fats extracted from the herbal nutritional energy bar are first converted into FAMEs to improve their thermal stability and volatility. These FAMEs are then vaporized and carried by an inert carrier gas, typically nitrogen or helium, through a capillary column. Due to differences in molecular weight, polarity, and boiling points, individual fatty acids are separated and detected using a flame ionization detector (FID). The retention time and peak area corresponding to each fatty acid allow for its identification and quantification. Gas chromatography offers high sensitivity, precision, and reproducibility for detailed fatty acid profiling in food products[70,71].

## Methodology

1. **Fat Extraction**:
   The crude fat was first extracted from the formulated herbal nutritional energy bar using the Soxhlet extraction method with an organic solvent.
2. **Preparation of Fatty Acid Methyl Esters (FAMEs)**:
   The extracted fat was subjected to a methylation process where it was treated with methanol and a catalyst, such as potassium hydroxide (KOH), to form fatty acid methyl esters, improving their volatility and thermal stability.
3. **Sample Injection**:
   A small quantity of the FAME sample was injected into the gas chromatograph equipped with a capillary column and a flame ionization detector (FID).
4. **Separation of Components**:
   Using an inert carrier gas like helium, the vaporized FAMEs were separated inside the column based on their molecular weight, chain length, and degree of saturation or unsaturation.
5. **Detection and Identification**:
   Fatty acids were detected as they exited the column, and their retention times were compared with those of known standard FAME mixtures for identification.
6. **Quantification**:
   The area under each chromatographic peak was measured to determine the relative concentration of saturated fats, monounsaturated fats (MUFA), polyunsaturated fats (PUFA), and trans fats.
7. **Data Analysis**:
   The fat composition was analyzed to assess the nutritional profile and quality of the herbal nutritional energy bar.

## 3. Protien

## Objective

The objective of protein analysis in herbal nutrition energy bars is to assess the quality, quantity, and types of proteins present in the product. By evaluating the protein content, the aim is to ensure the bars provide an adequate amount of essential amino acids necessary for muscle repair, growth, and overall health.

Additionally, the analysis helps determine the bioavailability and digestibility of the proteins, ensuring they are effectively absorbed by the body. Understanding the protein composition also aids in formulating bars that meet specific dietary needs and support energy production, especially for active individuals.

## Scope

The scope of protein analysis using Gerhardt nitrogen distillation in herbal nutrition energy bars is to determine the total protein content by measuring nitrogen levels. This method offers a consistent and dependable approach to evaluating proteins, especially in plant-based formulations. It helps confirm that the protein amounts meet the nutritional claims and comply with regulatory guidelines. Additionally, it plays an important role in quality control by ensuring product consistency during manufacturing. The analysis also assesses the nutritional value and digestibility of proteins. Gerhardt distillation can be applied to both ingredients and final products. Overall, it is essential for verifying the health benefits of herbal energy bars.

## Principle

The principle of protein analysis by Gerhardt nitrogen distillation is based on measuring the nitrogen content of a sample, as proteins are rich in nitrogen. The organic nitrogen is converted to ammonia through digestion and distillation. The released ammonia is collected and titrated to determine nitrogen content, which is then converted to total protein using a standard factor.[72]

## Methodology

1. **Sample Preparation**:
   Accurately weigh about 0.5 to 2 grams of the finely ground herbal nutrition energy bar sample and place it into a digestion flask.
2. **Digestion:**
   Add concentrated sulfuric acid ($H_2SO_4$) along with a catalyst mixture (usually potassium sulfate and copper sulfate) to the flask. Heat the mixture gently at first, then increase the temperature until the solution becomes clear. During this process, the organic nitrogen is converted into ammonium sulfate.
3. **Distillation:**
   After digestion, allow the solution to cool, then dilute it with distilled water. Add a strong alkali (usually sodium hydroxide) to liberate ammonia gas from

the ammonium sulfate. Distill the released ammonia into a known volume of standard acid (such as boric acid or sulfuric acid solution).

4. **Titration:**
Titrate the excess acid with a standard sodium hydroxide solution to determine how much acid reacted with the ammonia. The amount of acid neutralized corresponds to the nitrogen content of the sample.

5. **Calculation:**
Calculate the percentage of nitrogen in the sample. Multiply the nitrogen content by a standard conversion factor (commonly 6.25) to estimate the total protein content.

## 4. Carbohydrate

### Objective

To incorporate high-quality, natural carbohydrate sources into the herbal energy nutrition bar to provide sustained energy, support physical performance, and promote satiety.

### Scope

This includes the selection of complex carbohydrate sources like oats, dried fruits, and natural sweeteners that are consistent with the herbal and nutritional objectives of the product. The emphasis is placed on achieving a balanced glycemic response, improving the bar's taste and texture, and maintaining its overall health-promoting properties.

### Principle

The principle involves selecting complex carbohydrate sources for sustained energy release, considering their glycemic index and fiber content. The balance between simple sugars and complex carbs is essential for quick and prolonged energy, while fiber aids in digestion and overall health.

Total Carbohydrate Content (g)=∑(Weight of Each Ingredient (g)×Carbohydrate percentage per Ingredient)

## 5. Total Sugar

### Objective

The objective of this analysis is to measure the total sugar content as well as the sucrose content in herbal nutrition energy bars using a titration method. The study will concentrate on evaluating the sugar profile of the bars to gain a deeper understanding of their nutritional composition. This information is important for ensuring proper product labeling, meeting regulatory standards, and addressing consumer health concerns.

### Principle

### Total Sugar (Reducing and Non-Reducing Sugars):

The total sugar content in the herbal nutrition energy bar is measured by titrating with an appropriate reagent like Fehling's solution or Benedict's solution, which reacts with reducing sugars (such as glucose and fructose).[73]

### Sucrose content

Sucrose is a non-reducing sugar, so it does not react directly with Fehling's or Benedict's solution. To determine sucrose, the sample undergoes hydrolysis (using an acid like hydrochloric acid) to break it down into glucose and fructose, both of which are reducing sugars. [74]

### Methodology

Preparation of Sample
Weighing the Sample
Accurately weigh a known quantity (around 1–2 g) of the herbal nutrition energy bar.
Sample Homogenization:
Grind or crush the sample into a fine powder to ensure uniform distribution of ingredients.
Extraction of Sugars:
Extract sugars from the homogenized sample by dissolving it in distilled water.

Typically, heat may be applied to enhance extraction (e.g., boiling the sample for 10–15 minutes), and the mixture is then filtered to remove solid residues.

**Determination of Total Sugar (Reducing Sugars and Non-Reducing Sugars):**

Using Fehling's Solution (or Benedict's Solution) to Measure Reducing Sugars: Reagents Required: Fehling's A (Copper(II) sulfate) and Fehling's B (Alkaline tartrate solution).

1. **Preparation of Reagents**:
   Prepare fresh Fehling's A and B solutions.
2. **Titration Setup**:
   Mix equal volumes of Fehling's A and B solutions and add them to a titration flask.
3. **Titration Process**:
   Add the sugar extract (from the energy bar sample) to the titration mixture. Heat the solution to boil.
4. **End Point Determination**:
   As the reaction proceeds, a red precipitate of copper(I) oxide forms. The end point is reached when no more precipitate forms, and the solution remains clear.
5. **Calculation**:
   Calculate the amount of reducing sugar by using the volume of Fehling's solution required to reach the end point, based on a standard calibration curve.

**Determination of Sucrose (Non-Reducing Sugar):**

Hydrolysis of Sucrose to Glucose and Fructose:Reagents Required: Dilute hydrochloric acid (HCl), Fehling's solution.

1. **Sucrose Hydrolysis**:
   Add a known volume of the sugar extract to a test tube, and treat it with dilute HCl (approximately 2 M) to hydrolyze sucrose into its component monosaccharides (glucose and fructose). Heat the mixture for 30 minutes in a boiling water bath.
2. **Neutralization**:

After hydrolysis, neutralize the solution with a sodium hydroxide (NaOH) solution to adjust the pH to around 7.

3. **Titration of Reducing Sugars**:
   Perform the same titration procedure as for total sugars (using Fehling's solution) to measure the newly formed reducing sugars (glucose and fructose).
4. **Calculation**:
   The quantity of reducing sugars measured after hydrolysis represents the sucrose content in the original sample. The amount of sucrose can be calculated by considering the stoichiometry of sucrose hydrolysis (1 mol of sucrose yields 1 mol of glucose and 1 mol of fructose).

Calculation and Data Analysis:

**Total Sugar Calculation**:
The amount of reducing sugars determined by the titration process represents the total sugar content (excluding sucrose, which has been hydrolyzed into reducing sugars).

**Sucrose Calculation**:
The sucrose content is calculated from the increase in reducing sugars after hydrolysis. Since each mole of sucrose yields one mole of glucose and one mole of fructose, the total amount of reducing sugars (after hydrolysis) directly corresponds to the sucrose content.

## 6. Sodium

**Objective and scope**
The scope involves extracting sodium from the nutri bar sample and measuring it using a flame photometer. It includes preparing samples, using sodium standards for calibration, and following proper measurement techniques. This analysis helps in understanding the nutritional content, meeting regulatory requirements, aiding product formulation, and offering consumers reliable information about sodium levels in the product.

**Principle**

Flame photometry is based on the principle that certain metal ions, like sodium, emit light at specific wavelengths when introduced into a flame. In this method, the nutri bar sample is first prepared and atomized into a flame, where sodium ions become excited due to the flame's heat energy. As these excited sodium atoms return to their lower energy state, they emit light, primarily at a wavelength of 589 nm. The intensity of this emitted light is directly proportional to the concentration of sodium in the sample. By comparing the sample's emission intensity to that of known sodium standards, the sodium content in the nutri bar can be accurately determined.[75]

**Methodology**

Mix and Grind the sample to fine powder. Weight accurately, approx 1-10gm of well homogenized sample, into a cleaned and tared silica dish. Transfer the dish to a muffle furnace for ashing at 450-500°C. Continue ashing till practically carbon-free ash is obtained. After the ash is carbon-free remove the dish from furnace and cool. Treat the residue with 50 ml1:1 HCI, and transfer the entire residue to the 100 ml volumetric flask & allow to stand on water bath for 30 minutes. Cool the flask and makeup the volume to 100 ml using Distilled Water. From this solution as per requirement further dilute to get the concentration in the range of linearity.

$$\text{Na, K, Ca } \left(\frac{\text{mg}}{100\text{g}}\right) = \frac{\text{R X Dilution}}{\text{W X 10}}$$

Where,
R= Flame Photometry Reading
W= Weight of sample

## 7. Cholesterol

**Objective and scope**

The extracting cholesterol from the nutri bar sample, derivatizing if necessary, and analyzing it by GC. It covers sample preparation, method calibration, and data analysis. The results help in nutritional profiling, regulatory compliance, and providing consumers with reliable health information.

**Principle**

Gas chromatography (GC) is based on the separation of components within a mixture as they pass through a column under the influence of a carrier gas. In this method, cholesterol is first extracted from the herbal nutrition energy bar, and if needed, it is derivatized into a volatile compound (e.g., cholesterol esters). The sample is then injected into the GC system, where it is vaporized and carried through the column by an inert gas (such as helium). As the cholesterol components interact with the stationary phase of the column, they are separated based on their boiling points and affinities for the stationary phase. The separated components are detected by a detector (usually a flame ionization detector, FID), and the area under the peak corresponds to the concentration of cholesterol in the sample[76].

**Methodology**

**1. Saponification**

Weigh 2-3 grams of sample in a 250ml round bottom flask. Add 40ml of 95% Ethanol and 8ml of 50% KOH solution.

The samples are then allowed to reflux at 70◦C on water bath by attaching the condenser for 30-45 mins. Complete saponification can be ensured by occasional checking of the sample and any clumps should be dispersed with glass rod or by adding KOH solution to the sample while stirring.

While continuously stirring the solution, heating is stopped and 60 mL of 95% ethanol is added through the top of the condenser (Caution: Add carefully to avoid spurting of alcohol from the top of the condenser). The flask is removed from the condenser after 15 min, closed with a stopper, and the solution is cooled to room temperature. The sample is observed to remain stable for 24 hr.

**2. Extraction**

About 100 mL of toluene is added to the saponified sample while stirring. The flask is stoppered and stirred for 30 s. The solution is poured into 500 mL

separatory funnel.
Subsequently, 110 mL of 1 N KOH solution is added and the funnel is shaken vigorously for 10seconds. The layers are allowed to separate and the aqueous (lower) layer (will be turbid) is discarded. About 40 mL of 0.5 N KOH solution is added to the separatory funnel and the funnel is inverted and the contents are gently swirled for 10 s. The aqueous (lower) layer is discarded.
About 40 mL of H2O is added to wash the toluene layer, by gently rotating the separatory funnel. The layers are allowed to separate and the aqueous phase is discarded. The H2O washes are repeated at least thrice, by shaking more vigorously each time. If emulsification occurs, small amount 95% ethanol is added, the contents of the funnel are swirled, the layers are let to separate, and H2O washes are continued. The toluene layer should be crystal clear after the final wash.
The toluene layer is poured from the top of the separatory funnel through the glass funnel containing plug of glass wool and about 20 g of Na2SO4 into 125 mL Erlenmeyer flask containing about 2 g of Na2SO4. The flasks are stoppered and the contents are swirled. Th e mixture was let to stand for 15 min. The sample extracts may remain stable for 24 h if tightly sealed.
About 25 mL of the extract (V2) is pipetted into 125 g flat-bottom boiling flask and the contents are evaporated to dryness on the rotary evaporator at 40 3C. About 3 mL of acetone is added and the contents are evaporated to dryness again. Th e residue is dissolved in 3.0 mL of DMF. The final concentration of cholesterol in DMF should be within the range of working standard solutions.

### 3. Derivatization

One milliliter (1.0 mL) of aliquots of working standard solutions and the test solution are pipetted into separate 15 mL centrifuge tubes.
About 0.2 mL of HMDS and 0.1 mL of TMCS are added to each tube. The tubes are stoppered and shaken vigorously on the test tube mixer or by hand for 30s. The solution is left undisturbed for 15 min.
Subsequently, 1.0 mL of 5α-cholestane internal standard solution and 10 mL of H2O are added to each tube. The tubes are stoppered, shaken vigorously for 30 s, and centrifuged for about 2 min. Sufficient portion of heptane (upper) layer is transferred to the injection vial, but the aqueous layer should not be transferred. The standards and samples are derivatized and must be analyzed within 24 hr.

$$\text{Cholesterol} = \frac{\text{Conc. of cholesterol in } \frac{\text{mg}}{100\,\text{ml}} \text{ from std curve} \times V1 \times V3}{\text{Sample weight} \times V2}$$

where,

Cholesterol content (mg/100g)

V1 is the volume of toluene used in extraction

V2 is the aliquot of extract brought to dryness

V3 is the volume of DMF used to dissolve residue

## 8. Energy

### Objective

To describe the standard operating procedure for the calculation of energy.

### Principle

In energy calculation to the percentage of protein and carbohydrate multiply with 4 because 1 gm protein and carbohydrate gives 4 Kcal energy and percentage of fat multiply with 9 because 1g fat gives 9 Kcal energy.

### Calculation:

Energy Kcal = (4 x % Protein) + (4 x % Carbohydrate) +(9 x %Fat)

# Result

## Sensory Evaluation

*Table 6: Result and Observation of Sensory Evaluation*

| Sr. No. | Parameter | Observation /Result |
|---|---|---|
| 1. | Appearance and Color | Chocolate Brown |
| 2. | Texture | Crispiness and Cohesive ness |
| 3. | Taste | Sweet |
| 4. | Odour | Pleasant and Appetizing Aroma |

## Nutritional Evaluation

***Table 7: Result and Observation of Nutritional Evaluation***

| Sr. No. | Parameter | Result | % RDA |
|---|---|---|---|
| 1. | Fat | 23.60 | 35.2 |
| 2. | Saturated fat | 19.53 | 88.8 |
| 3. | Unsaturated fat | 4.07 | - |
| 4. | Trans fat | ND<0.05 | 0.0 |
| 5. | Protein (N*6.25) | 7.30 | - |
| 6. | Carbohydrate | 60.41 | - |
| 7. | Total Sugar | 40.59 | - |
| 8. | Sugar as Sucrose | 28.37 | 56.7 |
| 9. | Sodium | 40.1 | 2.0 |
| 10. | Cholesterol | ND<2.0 | - |
| 11. | Monounsaturated Fat | 2.75 | - |
| 12. | Polyunsaturated Fat | 1.32 | - |
| 13. | Energy | 483.3 | 24.2 |

## Future Scope

1. **Optimization of Nutritional Profile:**
   To improve the overall health benefits of the energy bar, future research should aim to reduce the levels of saturated fats and added sugars. At the same time, it is important to preserve the product's desirable taste and texture to maintain acceptability, especially among health-conscious individuals.

2. **Herbal Ingredient Research:**
   Upcoming studies should be directed toward evaluating the specific functional properties of the herbal components incorporated in the formulation. Particular attention should be given to assessing their antioxidant, anti-inflammatory, and digestive health effects using scientific methods.

3. **Shelf-Life and Storage Studies:**
   In order to ensure product stability and safety during storage, further investigation into the shelf-life of the energy bar under different environmental conditions is required. This would help in determining appropriate packaging and storage recommendations for commercial distribution.

4. **Advanced Nutritional Enhancement:**
   The nutritional value of the product may be further improved by enriching it with additional functional ingredients, such as dietary fiber, plant-based protein sources, omega-3 fatty acids, and essential micronutrients like calcium, iron, and vitamins.

## Summary

This study focused on the formulation, development, and evaluation of a herbal energy nutritional bar designed to be a healthy, functional, and consumer-friendly snack. The bar was developed using a systematic approach to meet nutritional demands while incorporating the benefits of herbal ingredients. Sensory evaluation indicated that the product had desirable attributes, including a chocolate brown color, cohesive and crisp texture, sweet taste, and pleasant aroma-qualities that suggest strong consumer acceptance potential.

Nutritional analysis revealed that the bar is rich in carbohydrates (60.41%) and provides significant energy (483.3 kcal per serving), making it suitable for active individuals. It also contains moderate protein (7.30%) to support muscle maintenance and recovery. The fat content (23.60%), largely composed of saturated fats (19.53%), contributes to taste but may need modification for improved health appeal. The absence of trans fats and cholesterol, along with a low sodium content (40.1 mg), further enhances its heart-health benefits. The inclusion of herbal ingredients may contribute antioxidant and digestive benefits, although these were not extensively explored in this study.

## Conclusion

1. The study demonstrated that a herbal energy nutritional bar can be developed as a functional food combining both health benefits and sensory appeal.
2. The final product showed favorable organoleptic characteristics, including chocolate-brown color, cohesive texture, sweet taste, and a pleasant aroma, overall acceptability.
3. Nutritional analysis confirmed the bar is a rich source of energy, carbohydrates, and protein, with low levels of sodium, trans fat, and cholesterol.

4. The inclusion of herbal ingredients potentially enhances the functional properties of the bar, offering added health benefits such as antioxidant or anti-inflammatory effects.
5. While the product meets key nutritional and sensory standards, further formulation efforts could focus on reducing saturated fat and sugar content to improve its health profile.
6. The study conclude the growing consumer demand for convenient, clean-label, and health-focused food products, showing that traditional herbal elements can be successfully integrated into modern nutrition.

1332

1333 *Appendix 1: Analytical Report*

# VARNI ANALYTICAL LLP

Testing of Food, Water, Packaging Material, Cosmetic Products & Ayurvedic Products
ISO/IEC 17025:2017, NABL Accredited Laboratory
ISO 9001:2015, ISO 14001:2015 & ISO 45001:2018 Certified

Varni LABS – Know your food

TC-13939

**ULR No.:** TC119392500000838 7

## TEST REPORT

**Lab Id No.:** VAL/2503/190070 **Report Date:** 31-03-2025

| Name & Address | Registration Date | Analysis Start Date | Analysis End Date |
|---|---|---|---|
| H.K College of Pharmacy.<br>HK Campus, Relief Road, Oshiwara, Jogeshwari West, Pratiksha Nagar, Mumbai, Maharashtra, India - 400102 | 19-03-2025 | 19-03-2025 | 25-03-2025 |

**Particulars of Sample Submitted**

**1) Sample Name:** Energy Nutri-Bar
**2) Batch No/Lot No:** Not Specified
**3) Sample Quantity:** Approx. 200 gm.
**4) Date of Collection:** 19-03-2025
**5) Description:** Sample packed in plastic bag.
**6) Sample Condition:** Acceptable
**7) Sample Submitted By:** Sample collected by lab personnel Ashish.
**8) Sampling Details:** Not Applicable
**9) Sample Drawn By:** Not Applicable
**10) Other Information:** -

**Analysis Results**

| Sr. No. | Test Parameter | Unit | Test Method | Test Result | %RDA |
|---|---|---|---|---|---|
| **Discipline** - CHEMICAL<br>**Group** - FOOD & AGRICULTURAL PRODUCTS | | | | | |
| 1 | Fat | g/100g | IS 15271: 2003 | 23.60 | 35.2 |
| 2 | Saturated fat | g/100g | IS 548 (Part 3/Sec 1) : 2021 | 19.53 | 88.8 |
| 3 | Unsaturated fat | g/100g | IS 548 (Part 3/Sec 1) : 2021 | 4.07 | - |
| 4 | Trans fat | g/100g | IS 548 (Part 3/Sec 1) : 2021 | ND<0.05 | 0.0 |
| 5 | Protein (N*6.25) | g/100g | IS 7219 :1973 | 7.30 | - |
| 6 | Carbohydrate | g/100g | IS 1656 : 2022 | 60.41 | - |
| 7 | Total Sugar | g/100g | IS 6287:1985 | 40.59 | - |
| 8 | Sugar as Sucrose | g/100g | IS 6287:1985 | 28.37 | 56.7 |
| 9 | Sodium | mg/100g | VAL/MOA/0018 | 40.1 | 2.0 |
| 10 | Cholesterol | mg/100g | AOAC 22nd Edition: 2023 | ND<2.0 | - |
| 11 | Monounsaturated Fat | g/100g | IS 548 (Part 3/Sec 1) : 2021 | 2.75 | - |
| 12 | Polyunsaturated Fat | g/100g | IS 548 (Part 3/Sec 1) : 2021 | 1.32 | - |
| 13 | Energy | Kcal/100g | VAL/SOP/0017 | 483.3 | 24.2 |

**Remarks:**
1. % values are based on a 2000 calories diet as per FSSAI gazette dtd. 17th Nov. 2020.

**AUTHORIZED SIGNATORY**
Ayesha Baig
Manager
**(Chemical)**

**AUTHORIZED SIGNATORY**
Mamta Chaudhari
Manager
**(Chemical)**

***** END OF REPORT *****

Scan to Download Report

**Notes:**
1. Results pertain only to the sample tested. Test report shall not be reproduced except in full, without written approval of the Technical Manager.
2. Sample(s) will be retained by us for a period of 15 days for non-perishable items only. Perishable items will be destroyed after completion of test.
3. Subject to Thane Jurisdiction.
4. ND – Not detected, BLQ- Below limit of quantification, NMT – Not more than, NLT – Not less than. BLD – Below Detection Limit.

TC Cert. & Scope



Add: 222 & 225, Shyam Industrial, Near Thakur Mall, Mira Road (E), Thane - 401107. Tel: 02246046054, 8080808363
Web: www.varnianalyticallabs.in | E-mail: sales@varnianalyticallabs.in

1334
1335

## Reference

1] Singh, R., et al. (2020). Herbal bars as functional foods: Nutritional and phytotherapeutic perspective. *Journal of Functional Foods*, *72*, 104061.

2] Granato, D., et al. (2020). Functional foods: Concept, technological aspects, and regulatory issues. *Trends in Food Science & Technology*, *98*, 1–18. https://doi.org/10.1016/j.tifs.2020.01.022

3] Panossian, A., & Wikman, G. (2010). Effects of adaptogens on the central nervous system and the molecular mechanisms associated with their stress—Protective activity. *Pharmaceuticals*, *3*(1), 188–224. https://doi.org/10.3390/ph3010188

4] Dhiman, A., et al. (2021). Ethnopharmacological aspects of herbal teas. *Plant Archives*, *21*(1), 1160–1167

5] Smith, L. P., et al. (2022). Nutraceutical bars: Functional formulation and product development. *Food Science & Nutrition*, *10*(1), 225–234

6] Slavin, J. (2013). Fiber and prebiotics: Mechanisms and health benefits. *Nutrients*, *5*(4), 1417–1435. https://doi.org/10.3390/nu5041417

7] Willett, W., et al. (2019). Food in the Anthropocene: The EAT–Lancet Commission on healthy diets from sustainable food systems. *The Lancet*, *393*(10170), 447–492. https://doi.org/10.1016/S0140-6736(18)31788-4

8] Augustin, L. S. A., et al. (2015). Glycemic index, glycemic load and glycemic response: An International Scientific Consensus Summit from the International Carbohydrate Quality Consortium (ICQC). *Nutrition, Metabolism and Cardiovascular Diseases*, *25*(9), 795–815. https://doi.org/10.1016/j.numecd.2015.05.005

9] Katiyar, S. K., & Mukhtar, H. (1996). Green tea polyphenol (-)-epigallocatechin-3-gallate treatment to mouse skin prevents UVB-induced infiltration of leukocytes, depletion of antioxidant enzymes and oxidative stress. *Carcinogenesis*, *17*(4), 761–765.

10] Allen, T., & Prosperi, P. (2016). Modeling sustainable food systems. *Environmental Management*, *57*(5), 956–975. https://doi.org/10.1007/s00267-016-0664-8

11] Friesen, B. N., et al. (2021). Functional foods as a bridge to herbal medicine: The consumer experience. *Journal of Herbal Medicine*, *26*, 100425. https://doi.org/10.1016/j.hermed.2021.100425

12] Devi, P. B., Vijayabharathi, R., Sathyabama, S., Malleshi, N. G., &Priyadarisini, V. B. (2011). *Health benefits of finger millet (Eleusine coracana L.) polyphenols and dietary fiber: A review*. Journal of Food Science and Technology, 51(6), 1021–1040. https://doi.org/10.1007/s13197-011-0584-9

13] Saleh, A. S. M., Zhang, Q., Chen, J., & Shen, Q. (2013). *Millet grains: Nutritional quality, processing, and potential health benefits*. Comprehensive Reviews in Food Science and Food Safety, 12(3), 281–295. https://doi.org/10.1111/1541-4337.12012

14] Chandrasekara, A., & Shahidi, F. (2011). *Antiproliferative potential and DNA scission inhibitory activity of phenolics from whole millet grains*. Journal of Functional Foods, 3(3), 159–170. https://doi.org/10.1016/j.jff.2011.03.006

15] Baliga, M. S., & Dsouza, J. J. (2011). *Amla (Emblica officinalis Gaertn), a wonder berry in the treatment and prevention of cancer*. European Journal of Cancer Prevention, 20(3), 225–239. https://doi.org/10.1097/CEJ.0b013e32834473f4

16] Poltanov, E. A., Shikov, A. N., Dorman, H. J. D., Pozharitskaya, O. N., Makarov, V. G., & Tikhonov, V. P. (2009). *Chemical and antioxidant evaluation of Indian gooseberry (Emblica officinalis Gaertn., syn. Phyllanthus emblica L.) supplements*. Phytotherapy Research, 23(9), 1309–1315. https://doi.org/10.1002/ptr.2775

17] Jagetia, G. C., & Baliga, M. S. (2004). *The evaluation of the radioprotective effect of Amla (Emblica officinalis) in mice exposed to gamma-radiation*. Phytomedicine, 11(6), 535–543. https://doi.org/10.1016/j.phymed.2003.07.001

18] Khan, K. H. (2009). *Roles of Emblica officinalis in medicine: A review*. Botany Research International, 2(4), 218–228.

19] Leone, A., Spada, A., Battezzati, A., Schiraldi, A., Aristil, J., & Bertoli, S. (2015). Moringa oleifera seeds and oil: Characteristics and uses for human health. *International Journal of Molecular Sciences*, 17(12), 2141. https://doi.org/10.3390/ijms17122141

20] Rockwood, J. L., Anderson, B. G., &Casamatta, D. A. (2013). Potential uses of Moringa oleifera and an examination of antibiotic efficacy conferred by M. oleifera seed and leaf extracts using crude extraction techniques available to underserved indigenous populations. *International Journal of Phytotherapy Research*, 3(2), 61-71.

21] Saini, R. K., Sivanesan, I., & Keum, Y. S. (2016). Phytochemicals of Moringa oleifera: A review of their nutritional, therapeutic and industrial significance. *3 Biotech*, 6(2), 203. https://doi.org/10.1007/s13205-016-0526-3

22] Gopalakrishnan, L., Doriya, K., & Kumar, D. S. (2016). Moringa oleifera: A review on nutritive importance and its medicinal application. *Food Science and Human Wellness*, 5(2), 49-56. https://doi.org/10.1016/j.fshw.2016.04.001

23] Stohs, S. J., & Hartman, M. J. (2015). Review of the safety and efficacy of Moringa oleifera. *Phytotherapy Research*, 29(6), 796-804. https://doi.org/10.1002/ptr.5325

24] Bedigian, D. (2003). Evolution of sesame revisited: domestication, diversity and prospects. *Genetic Resources and Crop Evolution*, 50(7), 779–787. https://doi.org/10.1023/A:1025029903549

25] Namiki, M. (2007). Nutraceutical functions of sesame: A review. *Critical Reviews in Food Science and Nutrition*, 47(7), 651–673. https://doi.org/10.1080/10408390600919114

26] Kanu, P. J. (2011). Biochemical analysis of black and white sesame seeds from China. *American Journal of Biochemistry and Molecular Biology*, 1(2), 145–157. https://doi.org/10.3923/ajbmb.2011.145.157

27] Hirose, N., Inoue, T., Nishihara, K., et al. (1991). Inhibition of cholesterol absorption and synthesis in rats by sesamin. *Journal of Lipid Research*, 32(4), 629–638

28] Baliga, M. S., Baliga, B. R. V., Kandathil, S. M., Bhat, H. P., &Vayalil, P. K. (2011). A review of the chemistry and pharmacology of the date fruits (*Phoenix dactylifera* L.). *Food Research International*, 44(7), 1812–1822. https://doi.org/10.1016/j.foodres.2010.07.004

29] Rao, P. U. (2007). Nutritional composition and acceptability of sweet preparations with jaggery. *Plant Foods for Human Nutrition*, 62(2), 61–64. https://doi.org/10.1007/s11130-007-0040-3

30] Bhattacharya, S., & Chakraborty, S. (2013). Jaggery as an alternative sweetener in Indian diets: Its health benefits and utilization. *Journal of Food Science and Technology*, 50(4), 807–813. https://doi.org/10.1007/s13197-011-0413-2

31] Chavan, J. K., Kadam, S. S., & Salunkhe, D. K. (2009). Production and utilization of jaggery in India: A review. *Journal of Food Science and Technology*, 46(2), 161–169.

32] Al-Shahib, W., & Marshall, R. J. (2003). The fruit of the date palm: Its possible use as the best food for the future? *International Journal of Food Sciences and Nutrition*, 54(4), 247–259. https://doi.org/10.1080/09637480120091982

33] Miller, C. J., Dunn, E. V., & Hashim, I. B. (2003). Glycemic index of 3 varieties of dates. *Saudi Medical Journal*, 24(5), 536–538.

34] Vayalil, P. K. (2012). Date fruits (Phoenix dactylifera Linn): An emerging medicinal food. *Critical Reviews in Food Science and Nutrition*, 52(3), 249–271. https://doi.org/10.1080/10408398.2010.499824

35] Biglari, F., AlKarkhi, A. F. M., & Easa, A. M. (2008). Antioxidant activity and phenolic content of various date palm (Phoenix dactylifera) fruits from Iran. *Food Chemistry*, 107(4), 1636–1641. https://doi.org/10.1016/j.foodchem.2007.10.007

36] Settaluri, V. S., Kandala, C. V. K., Puppala, N., & Sundaram, J. (2012). Peanuts and their nutritional aspects—A review. *Food and Nutrition Sciences*, 3(12), 1644–1650. https://doi.org/10.4236/fns.2012.312215

37] Ros, E. (2010). Health benefits of nut consumption. *Nutrients*, 2(7), 652–682. https://doi.org/10.3390/nu2070652

38] Kris-Etherton, P. M., Hu, F. B., Ros, E., &Sabaté, J. (2008). The role of tree nuts and peanuts in the prevention of coronary heart disease: Multiple potential mechanisms. *The Journal of Nutrition*, 138(9), 1746S–1751S. https://doi.org/10.1093/jn/138.9.1746S

39] Francisco, M. L. D. L., &Resurrección, A. V. A. (2009). Functional components in peanuts. *Critical Reviews in Food Science and Nutrition*, 48(8), 715–746. https://doi.org/10.1080/10408390701638866

40] Devi, P. B., Vijayabharathi, R., Sathyabama, S., Malleshi, N. G., &Priyadarisini, V. B. (2014). Health benefits of finger millet (*Eleusine coracana* L.) polyphenols and dietary fiber: A review. *Journal of Food Science and Technology*, 51(6), 1021–1040. https://doi.org/10.1007/s13197-011-0584-9

41] Hegde, P. S., Rajasekaran, N. S., & Chandra, T. S. (2005). Effects of the antioxidant properties of millet species on oxidative stress and glycemic status in alloxan-induced rats. *Nutrition Research*, 25(12), 1109–1120. https://doi.org/10.1016/j.nutres.2005.09.013

42] Malleshi, N. G. (2007). Nutritional and technological characteristics of small millets and their utilization for health foods. In *Proceedings of the National Seminar on Millets: Future Food and Farming* (pp. 71–78).

43] Shobana, S., Krishnaswamy, K., Sudha, V., Malleshi, N. G., Anjana, R. M., Palaniappan, L., & Mohan, V. (2013). Finger millet (*Eleusine coracana*) and kodo millet (*Paspalum scrobiculatum*) as sources of antioxidant activity and dietary fiber: Evidence from in vitro and human intervention studies. *The British Journal of Nutrition*, 110(3), 529–537. https://doi.org/10.1017/S0007114512005003

44] Obilana, A. B., &Manyasa, E. (2002). *Millets*. In: P. S. Belton & J. R. N. Taylor (Eds.), *Pseudocereals and Less Common Cereals* (pp. 177–217). Springer. https://doi.org/10.1007/978-3-662-09544-7_6

45] Devi, P. B., Vijayabharathi, R., Sathyabama, S., Malleshi, N. G., &Priyadarisini, V. B. (2011). Health benefits of finger millet polyphenols and dietary fiber: A review. *Journal of Food Science and Technology*, 48(6), 535–541. https://doi.org/10.1007/s13197-010-0196-0

46] Rao, B. D., Platel, K., & Srinivasan, K. (2017). Bioaccessibility of iron and zinc from cereals and pulses consumed in India. *Current Science*, 112(5), 892–898. https://doi.org/10.18520/cs/v112/i05/892-898

47] Ravindran, G. (2022). Nutritional composition and quality traits of millets: A review. *Food Reviews International*, 38(2), 174–202. https://doi.org/10.1080/87559129.2020.1749214hammer

48] Raju, P. N., & Naik, R. K. (2020). Nutritional and therapeutic benefits of ghee. *International Journal of Food and Nutritional Sciences*, 9(2), 38–44.

49] Hamer, H. M., Jonkers, D., Venema, K., Vanhoutvin, S., Troost, F. J., & Brummer, R. J. (2008). Review article: The role of butyrate on colonic function. *Alimentary Pharmacology & Therapeutics*, 27(2), 104–119. https://doi.org/10.1111/j.1365-2036.2007.03562.x

50] Manohar, R., Dorairaj, S., & Krishna, R. (2013). Health benefits of ghee: A scientific review. *Journal of Ayurveda and Holistic Medicine*, 1(6), 7–12.

51] Bhatt, A., Mehta, S., & Shah, V. (2021). Lipid-based delivery systems in Ayurvedic functional foods: Role of ghee in enhancing bioavailability. *Journal of Functional Foods*, 85, 104645. https://doi.org/10.1016/j.jff.2021.104645

52] Giri, A., Narayanappa, R., & Ramesh, M. N. (2019). Stability of ghee: A review. *International Journal of Dairy Technology*, 72(3), 394–403. https://doi.org/10.1111/1471-0307.1261048]

53] Afoakwa, E. O. (2010). *Chocolate Science and Technology*. Wiley-Blackwell.

54] Beckett, S. T. (2008). *Industrial Chocolate Manufacture and Use* (4th ed.). Wiley-Blackwell.

55] Katz, D. L., Doughty, K., & Ali, A. (2011). Cocoa and chocolate in human health and disease. *Antioxidants & Redox Signaling*, 15(10), 2779–2811. https://doi.org/10.1089/ars.2010.3697

56] Grassi, D., Lippi, C., Necozione, S., Desideri, G., & Ferri, C. (2005). Short-term administration of dark chocolate is followed by a significant increase in insulin sensitivity and a decrease in blood pressure. *The American Journal of Clinical Nutrition*, 81(3), 611–614.

57] Pase, M. P., Scholey, A. B., &Pipingas, A. (2013). Cocoa polyphenols and cognition: Theoretical mechanisms of action and a review of the experimental evidence. *Molecules*, 18(5), 1938–1951. https://doi.org/10.3390/molecules18051938

58] Aidoo, R. P., Afoakwa, E. O., & Dewettinck, K. (2013). Industrial manufacture of sugar-free chocolates – Applicability of alternative sweeteners and carbohydrate polymers. *Journal of Food Science and Technology*, 50(4), 721–731. https://doi.org/10.1007/s13197-011-0404-1

59] Boirie, Y., Dangin, M., Gachon, P., Vasson, M.-P., & Laigle, M. (1997). Slow and fast dietary proteins differently modulate postprandial protein retention. *The American Journal of Clinical Nutrition*, 65(3), 694–699. https://doi.org/10.1093/ajcn/65.3.694

60] Kinsella, J. E., & Whitehead, D. M. (2011). Milk and milk products. In *Handbook of Food Science, Technology, and Engineering* (pp. 227–237). CRC Press.

61] Micha, R., Peñalvo, J. L., Cudhea, F., & Caio, S. (2017). The state of US diets, 2003-2016: A comprehensive analysis of food consumption and its effects on health. *Journal of Nutrition*, 147(2), 232–239. https://doi.org/10.3945/jn.116.245524

62] Berryman, C. E., West, S. G., & Kris-Etherton, P. M. (2015). Almonds and cardiovascular risk factors: A review of the evidence. *Journal of Nutrition*, 145(7), 1139–1148. https://doi.org/10.3945/jn.114.199451

63] Santos, D., Perez, J., & Silva, J. A. (2018). Health benefits of almonds: A review of the recent literature. *Food Research International*, 107, 235–245. https://doi.org/10.1016/j.foodres.2018.02.029

64] Zhang, Z., Zhou, Q., & Zhang, Y. (2016). The effects of almonds on human health: A review. *Journal of Functional Foods*, 26, 209–215. https://doi.org/10.1016/j.jff.2016.08.010

65] AOAC. Official Methods of Analysis of the AOACInternational, 18thed. Association of Official Analytical chemists, Gaithersburg, MD; c2005.

66] Stone, H., & Sidel, J. L. (2004). *Sensory Evaluation Practices* (3rd ed.). Academic Press.

67] Meilgaard, M., Civille, G. V., & Carr, B. T. (2007). *Sensory Evaluation Techniques* (4th ed.). CRC Press.

68] López-Álvarez, M., Blanco, M., Macías, M., & Laca, A. (2010). Determination of fat content in foods by Soxhlet extraction. *Food Chemistry*, 121(4), 1135-1140.

69] Azadmard-Damirchi, S., Fathi-Achachlouei, B., & Hesari, J. (2005). A review of Soxhlet extraction: Strengths and limitations. *Journal of Food Quality*, 28(6), 445–456.

70] Christie, W. W. (1998). *Gas Chromatography and Lipids: A Practical Guide*. The Oily Press.

71] AOCS (American Oil Chemists' Society). (2017). *Official Methods and Recommended Practices of the AOCS*. 7th Edition.

72] Gerhardt GmbH & Co. KG. (n.d.). *Kjeldahl method for nitrogen and protein determination*. Retrieved from https://www.gerhardt.de

73] Hort, J., & MacDougall, D. (2007). *Introduction to Food Chemistry* (2nd ed.). Springer.

74] Dubois, M., Gilles, K. A., Hamilton, J. K., Rebers, P. A., & Smith, F. (1956). Colorimetric method for determination of sugars and related substances. *Analytical Chemistry*, *28*(3), 350-356. https://doi.org/10.1021/ac60111a017

75] Skoog, D. A., Holler, F. J., & Crouch, S. R. (2017). *Principles of Instrumental Analysis* (7th ed.). Cengage Learning.

76] McNair, H. M., & Miller, J. M. (2011). *Basic Gas Chromatography* (2nd ed.). Wiley-Interscience.

1536