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Development & Assessment of Oats Bites Incorporating with Fruit Leather

Tisha Punjabi*

Student, Jaipur National University.

*Corresponding Author: tishapunjabi24@gmail.com

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ABSTRACT

The complex nature of atherosclerosis is influenced by a number of factors, including age. The aim of prevention and therapy is to eliminate the risk factors identified or reduce their detrimental effects. Regardless of the degree to which aging itself plays a role in the sickness process, coronary heart disease, cerebrovascular accident, aortic aneurysm, occlusive peripheral vascular disease, and phlebothrombosis are the most common and serious cardiovascular disorders among older adults. Kiwi is a well-known antioxidant fruit that has gained popularity because of its many therapeutic uses and high yield. It is abundant in carotenoids, phenolics, ascorbic acid, and other antioxidants. Rich in antioxidants, kiwis reduce the risk of chronic illnesses including diabetes, cancer, heart disease, and stroke. The nutritional and functional qualities of sweet potatoes (Ipomoea batatas (L.) Lam) have drawn attention to them in recent decades. Oats have become more popular as a meal in recent years since they are thought to provide a number of health advantages. The bran of oats is not as physically different as that of other cereals, which makes them unique. Walnuts' relatively quick effects on a number of CVD targets lend credence to the idea that they should be a part of any heart-healthy diet. A remarkable oil seed crop, sunflowers (Helianthus annuus) are grown all over the world for their seeds. Sunflower seeds are a nutrient-dense diet that may help with cancer, heart disease, skin disorders, bacterial and fungal infections, and chronic inflammatory problems.

***Keywords**: Cardiovascular Disease, Kiwi, Oats, Sweet Potato, Walnuts, Sunflower Seeds.*

Introduction

Cardiovascular disease (CVD) encompasses a broad range of conditions, such as illnesses of the heart muscle and the vascular system that supplies the heart, brain, and other essential organs. Regional variations in the burden of CVD are shown, together with an assessment of the epidemiological change that has made it the world's leading cause of death. Additionally, it examines the cost-effectiveness of several therapies aimed at the most pertinent causes of morbidity and death from CVD **(Gaziano *et al*., 2006).** In India, cardiovascular diseases (CVDs) are the primary cause of death and disability. In 2017, they were responsible for 14.7% of disability-adjusted life years (DALYs) worldwide and 31.8% of all deaths. Even if the burden of CVD has decreased somewhat in India in recent years, as has been the case in many other regions of the world, the disease still accounts for the majority of deaths and DALYs in the nation. In India, this change is presenting a significant public health concern. According to projections from the World Health Organization (WHO), around 17.9 million people died from CVDs in 2019, accounting for 32% of all deaths globally **(Jan *et al*., 2024).**

Kiwis' potassium and fibre promote heart health. Fiber can lower elevated cholesterol, potentially lowering the risk of heart attack and heart disease. Hypertension, myocardial infarction, and heart disease are all linked to low magnesium levels. Fresh kiwi fruit is a great source of potassium, an electrolyte that is good for the heart. There are 312 mg, or 7% electrolyte, in 100 g. A person's best chance of lowering their risk of cardiovascular disease is to increase their consumption of potassium and decrease their intake of salt. Potassium is a crucial part of bodily fluids and cells that assist control heart rate by reversing the negative effects of sodium. Omega-3 fatty acid content is high in kiwi fruit seeds. A number of studies indicate that eating foods high in omega-3 fatty acids may lower your risk of stroke and coronary heart disease. The chances of heart disease were also decreased by folate, magnesium, and vitamin E **(Tyagi *et al*., 2015).**

Consuming sweet potato roots has been demonstrated to lower insulin resistance, scavenge reactive oxygen species (ROS), lower hyperlipidaemia and hyperglycaemia in rats, and shield against a variety of liver damage **(Chang *et al*., 2021).** Particular emphasis has been paid to anthocyanin and phenolic compounds because to indications that they help shield the body from oxidative stress, which has been linked to cardiovascular disorders, cancer, and aging. The antioxidative and antimutagenic properties of sweet potato roots and leaves have been studied (**Grebla *et al*., 2021).**

Bioactive substances found in oats have the potential to improve human nutrition and health. The properties of oats and the information found in the literature that suggests eating oats may help prevent or control high blood pressure **(Bouchard *et al*., 2022).** The risk of CVD is known to be increased by elevated levels of low-density lipoproteins (LDL) and blood cholesterol. However, it has been demonstrated that eating oats lowers blood levels of both LDL and total cholesterol, which lowers the risk of CVD **(Paudel *et al*., 2021).** Changes in vascular function, which are indicative of heart attack and stroke, are identified using the augmentation index and aortic pulse wave velocity. There is evidence that eating dairy products and milk can help lower blood pressure. Subjects who ate low-fat dairy products had lower diastolic and systolic blood pressure, according to the DASH trial. Subsequent research has demonstrated a much lower relative risk for hypertension, confirming these associations **(Lordan *et al*., 2018).** The significance of milk in the human diet and the potential benefits of consuming it in avoiding a number of chronic illnesses, including diabetes, obesity, cardiovascular diseases (CVDs), and some types of cancer. The two most common adverse responses to milk intake are lactose malabsorption symptoms and cow milk protein allergy **(Pereira, 2014).**

Walnuts are known to have anti-inflammatory and antioxidant properties, and several studies have evaluated their ability to prevent the onset and progression of illnesses including cancer, heart disease, and neurological disorders **(Fatima *et al*., 2018).** Consuming walnuts has been linked to a number of health benefits, such as a lower risk of cardiovascular disease, coronary heart disease, type II diabetes, the prevention and treatment of some types of cancer, and a reduction in the symptoms of age-related and other neurological disorders. Consuming walnuts is thought to provide health advantages because of its fatty acid composition, which is high in polyunsaturated fatty acids and has the greatest ω3: ω6 ratio of any tree nut **(Hayes *et al*., 2016).** The consumption of natural honey has been demonstrated to inhibit oxidation of low-density protein, vasodilated blood vessels due to nitric oxide production, decrease platelet aggregation, exert analgesic and anti-atherogenic effects, and exhibit a wide range of biological activities and is rich in phenolic acids and flavonoids. It has been hypothesized that honey contributes to the reduction of cardiovascular diseases primarily due to flavonoid-mediated antioxidant, anti-inflammatory, immunomodulatory, and antimicrobial activities **(Farooqui & Farooqui, 2011).**

Sunflower seed has a high nutritional and food value and is a good source of proteins, nutrients, phytochemicals, and healthy unsaturated fats. It has antibacterial, analgesic, hypocholesterolaemia, anti-inflammatory, antihypertensive, skin-protective, anticancer, and antioxidant properties. It also has calming effects on blood vessels, muscles, and nerves. It is also utilized in constipation, dysentery, and urinary issues **(Pal, 2011).** Among other nutrients, sunflower seeds are high in vitamin E, iron, selenium, zinc, copper, and calcium. They also play a significant part in preventing cardiovascular disease and, because of their high fibre content, aid in digestion **(Pal & Molnar, 2021).**

Materials and Methodology

- **Procurement of Raw Material**

The raw material and other ingredients (Kiwi, Sweet Potato, Oats, Walnuts, Sunflower seeds, Honey and Milk Powder) required for the preparation of value-added products was collected from the local market of Jagatpura area of Jaipur.

- **Processing of Pulp and Peel**

The procured fresh kiwi fruit was sorted, washed thoroughly and cut into small pieces. The kiwi pulp was then heated at 50-55°C for 5 minutes adding 5% sweet potato. While heating the pulp, sweet potato was mixed properly, and the mixture was further grinded and spread into a thin layer (0.8cm) in aluminium trays. The drying of kiwi and sweet potato pulp in a tray-drier at 55°C for 4-5 hours was done and the leather prepared was cut into small pieces.

- **Processing of Other Raw Materials**

The oats and sunflower seeds were checked for any infestation or damage and were roasted at 150°C for 15 minutes separately. The walnuts were finely chopped and all ingredients were stored in sealed aluminium pouches.

- **Preparation of Bites**

The preparation of oats bites incorporating fruit leather involved multiple steps to ensure desirable texture, flavour, and nutrient retention. Oats and sunflower seeds were first dry roasted under controlled heat to enhance flavour, reduce moisture, and improve the stability of the final product. Walnuts were finely chopped to facilitate even distribution and improve palatability, after which the roasted oats, sunflower seeds, and walnuts were thoroughly mixed to form the primary base. Honey was incorporated as a natural sweetener and binding agent, while milk powder was added to enhance protein content, provide a creamy mouthfeel, and improve structural integrity of the bites. The mixture was kneaded into a uniform dough and a portion was placed in a standardized bites mould to form the base layer. A small piece of fruit leather was inserted at the centre to serve as the functional core, imparting natural sweetness, chewiness, and bioactive compounds from the fruit. An additional portion of the mixture was layered over the fruit leather, and the contents were pressed firmly to ensure compaction and cohesion of layers. Finally, the moulded bites were carefully demoulded, yielding a ready-to-eat, nutrient-dense snack with a chewy oat-based matrix enclosing a fruit leather core.

- **Sensory Evaluation of Bites**

Organoleptic evaluation of developed products Nine-point hedonic scale was used for the evaluation of organoleptic qualities of develop product. It rates the sensory trait considering 9 for excellence and 1 for disliking extremely. The score was used for evaluating the products quality viz. appearance, colour, taste, after taste and acceptability (Srilakshmi, 2010).

Quality Evaluation of the Bites

- **Antioxidant Activities Analysis**

Antioxidant activity was evaluated using multiple assays, including DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging activity and Ferric Reducing Antioxidant Power (FRAP). For these analyses, the sample extracts were prepared in acidified 80% methanol and subjected to standard experimental protocols. The DPPH radical scavenging ability of the samples was determined following the procedure of Brand-Williams et al. (1995), with absorbance measured at 517 nm using a spectrophotometer. FRAP values were assessed according to the method of Benzie and Strain (1999), which involves the reduction of ferric tripyridyltriazine (Fe^{3+}-TPTZ) complex to its ferrous form (Fe^{2+}) through electron donation by antioxidants.

- **Statistical Analysis**

All experiments were performed in triplicate, and the results were expressed as mean ± standard deviation. Statistical analysis was conducted using the Statistical Package for Social Sciences (SPSS), Version 20.0. An independent t-test was applied to assess significant differences between the mean values of the control and antioxidant-enriched bars, with significance levels considered at both 5% and 1%.

Results and Discussion


T1


T2


T3


T4

- **Sensory Evaluation of Bites**

The data available in the table1. that the Treatment 1 was liked extremely by 40% of the judges, was liked very much by 50 % of the judges and was liked moderately by 10% of the judges. The Treatment 2 was liked extremely by 80% of the judges, was liked very much by 10% of the judges and was liked moderately by 10% of the judges. The Treatment 3 was liked extremely by 10% of the judges, was liked very much by 30% of the judges was liked moderately by 60% of the judges. Treatment 4 was liked moderately by 20% of the judges, was liked slightly by 60% of the judges, was neither like nor dislike by 20% by the judges.

Table 1: Sensory evaluation of developed Oats fruit leather bites

Treatment	Liked extremely	Liked very much	Liked moderately	Liked slightly	Neither like nor dislike	Disliked slightly	Disliked moderately	Disliked very much	Disliked extremely
T0	60%	10%	30%	-	-	-	-	-	-
T1	40%	50%	10%	-	-	-	-	-	-
T2	80%	10%	10%	-	-	-	-	-	-
T3	10%	30%	60%	-	-	-	-	-	-
T4	-	-	20%	60%	20%	-	-	-	-

- **Sensory Quality of Oats Fruit Leather Bites using ANOVA**

Sensory evaluation of the developed oats fruit leather bites showed significant variation among treatments in terms of colour, texture, appearance, taste, aroma, and overall acceptability (Table 2). Treatment T2 consistently achieved the highest scores across all sensory attributes, with ratings of 8.5 for colour and appearance, and 8.4 for texture, taste, aroma, and overall acceptability, indicating that it was “very much liked” by the panel members. In comparison, T0 and T1 were moderately liked, while T3 and T4 received lower scores, reflecting only moderate acceptance. The superior performance of T2 may be attributed to its balanced formulation, which optimized the proportion of oats and fruit leather, resulting in a more appealing colour, enhanced texture, and improved flavour profile. The higher taste and aroma scores further suggest better integration of natural sweetness and fruit-derived volatiles, contributing to greater consumer preference. Overall, these findings highlight that treatment T2 was the most acceptable formulation, demonstrating the potential of incorporating fruit leather with oats to develop a nutritious and sensorially appealing functional snack.

Table 2: Mean±SD Score of Sensory evaluation of Oats fruit leather bites

Treatments	Colour	Appearance	Aroma	Texture	Taste	Overall
T0	8.0±0.9	8.1±1.0	7.9±1.03	8.1±0.9	8.2±0.8	8.1±0.8
T1	8.2±0.8	8.2±0.7	8.1±1.02	8.0±0.88	8.1±0.76	8.0±0.76
T2	8.5±0.6	8.5±0.8	8.4±0.90	8.4±0.90	8.4±1.1	8.4±0.90
T3	7.5±0.9	7.5±0.9	7.5±1.00	7.5±1.00	7.7±0.87	7.4±0.95
T4	6.6±0.92	6.8±0.88	6.9±0.98	6.9±0.98	6.7±0.95	6.5±0.98
f value	14.704*	23.642*	13.251*	19.723*	19.136*	45.069*
p value	0.00	0.00	0.00	0.00	0.00	0.00

*Significance at 0.01 % level

**Significance at 0.05% level

- **Nutrient analysis of oats fruit leather bites**

The proximate composition of the developed oats fruit leather bites revealed that treatment 2 outperformed the control across all parameters, highlighting the nutritional and functional benefits of oat incorporation (Table 3). Treatment 2 exhibited higher moisture (4.5 g) compared to the control (1.66 g), attributable to the water-binding capacity of oats, which contributed to a softer and more acceptable texture. Fat (13.0 g vs. 8.8 g), protein (3.37 g vs. 1.03 g), ash (2.4 g vs. 1.0 g), fibre (2.13 g vs. 0.9 g), and carbohydrate (74.4 g vs. 52.5 g) contents were also significantly higher in treatment 2. These compositional improvements were consistent with sensory scores, where treatment 2 achieved the highest ratings for colour (8.5), texture (8.4), appearance (8.5), taste (8.4), aroma (8.4), and overall acceptability (8.4), all falling in the “very much liked” category. The superior sensory performance may be linked to the improved nutrient composition, as higher protein and fat levels contributed to flavour and mouthfeel, while enhanced fibre and moisture levels improved chewiness and texture. In contrast, the control and other treatments received only moderate acceptance, with lower scores across most attributes. Overall, these results suggest that the incorporation of oats not only enhances the nutritional quality of fruit leather bites by improving their macronutrient and mineral content but also significantly improves their sensory appeal, making treatment 2 the most promising formulation for consumer acceptance.

- **Antioxidant Activities**
  - **DPPH:** The DPPH radical scavenging activity was recorded as 86.70% for treatment 2 and 75.55% for the control. A statistically significant difference ($p < 0.05$ and $p < 0.01$) was observed between the two groups. Previous studies have reported that oats exhibit considerable antioxidant potential, largely attributed to their phenolic compounds. Comparative evaluations of Indian oat cultivars have shown variation in DPPH radical scavenging activity, which was strongly correlated with total phenolic content. Similarly, research on Himalayan-grown oats suggested that processing techniques such as germination and roasting can further enhance their antioxidant activity. In addition, fruit leathers, including those prepared from papaya and lapsi (*Choerospondias axillaris*), have also been assessed for their antioxidant properties, with results indicating that both fruit type and preparation method significantly influence DPPH scavenging activity**.**
  - **FRAP:** The FRAP values of treatment 2 and the control were 12.74 mM and 9.05 mM, respectively, with differences found to be statistically significant at both $p < 0.05$ and $p < 0.01$. A study entitled *Formulation and characterization of fruit leather based on Annona muricata L. fruit and Avena sativa flour* highlighted the development of fruit leathers prepared with soursop pulp and oat flour. While the primary emphasis was on the physical and chemical properties of the product, the work also acknowledged the contribution of bioactive compounds and phytochemicals in Annona muricata to antioxidant activity, including ferric reducing power. Likewise, fruit leathers enriched with Natal Plum (Carissa macrocarpa) demonstrated enhanced phytochemical content and antioxidant activity, with FRAP assay results confirming that incorporation of antioxidant-rich fruits can substantially improve the overall antioxidant potential of fruit leathers.

Table 3: Nutrient analysis of Treatment 2 and control by using T-test

Sr. No.	Nutrients	Treatment 2	Control	Calculated t Value	Calculated p Value
1	Moisture (g)	4.55±0.5	1.66±0.9	5.43**	0.005
2	Fat (g)	13.08±0.8	8.8±0.7	8.42**	0.001
3	Protein (g)	3.37±0.6	1.03±0.5	6.09**	0.003
4	Ash (g)	2.4 ±0.2	1.0±0.4	6.93**	0.002
5	Fibre (g)	2.13±0.4	0.90±0.5	4.02**	0.0016
6	Carbohydrate (g)	74.47±1.0	52.45±1.2	24.29**	0.23
7	DPPH (%)	86.70±0.2	75.55±0.5	2.03**	0.001
8	FRAP (mm)	12.74±0.5	9.05±0.9	1.09**	0.003

** significance at 0.01% level

- **Shelf-life analysis of the developed oats fruit leather bites**

To evaluate the microbiological stability of the product over time, a Statistical Process Control (SPC) analysis was conducted based on microbial counts (CFU/ml) measured at three time points: Day 0, Day 15, and Day 30. The objective was to determine whether the process remained within acceptable microbiological control limits throughout the observation period.

As shown in Table 3, the microbial load increased gradually over the 30-day period. The initial reading at Day 0 was 0 CFU/ml, indicating a sterile or contamination-free state. By Day 15, the count rose to 7 CFU/ml, and further increased to 21 CFU/ml by Day 30.

Table 4: SPC count of developed oats fruit leather bites

Time (Days)	SPS (CFU/g)	Recommended (CFU/g)
0	0	$< 1 \times 10^3$
15	7	$< 1 \times 10^4$
30	21	$< 1 \times 10^5$

Conclusion

Oats fruit leather bites are an innovative functional snack that combines the nutritional richness of oats and fruits into a convenient, shelf-stable form. Oats provide bioactive compounds like avenanthramides and beta-glucans, which support heart health, glycaemic control, and immunity, while fruits supply vitamins, minerals, and polyphenols with strong antioxidant effects. Together, they create a synergistic blend that enhances antioxidant capacity and overall wellness. Processing methods such as dehydration help retain these nutrients, and variations in fruit (e.g., berries, mango) or oat types allow customization for health and taste. Advances like fermentation or germination can further boost bioavailability of antioxidants. High-antioxidant fruits such as blueberries enhance benefits against oxidative stress and inflammation. With rising demand for clean-label, plant-based snacks, these bites appeal to athletes, children, professionals, and health-conscious individuals. Overall, they represent a forward-looking innovation in functional foods, delivering natural antioxidants, sustained energy, and wellness support.

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