DEVELOPMENT OF READY-TO-EAT NUTRIENT BAR

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Globally, public health organizations are concerned with promoting a healthy, balanced diet to reduce non-communicable diseases and obesity. Modern lifestyles drive demand for more convenient ready-to-eat food products. Concentrated, compressed nutrient bars have become a viable option for those seeking fibre-rich, protein-rich, and low-calorie quick meals. This study aimed to develop a nutrient bar incorporating protein using underutilized ingredients. The base formulation consisted of 30% soy as the main ingredient, with 15% sesame, 15% desiccated coconut, 15% *Terminalia catappa* **(**Indian almond), 15% pumpkin seeds, and 5% each of raisins and dates. Nutrient bars were produced using varying percentages of mushroom powder (0%, 2%, 5%, and 10%.). Sensory analysis was conducted with thirty untrained panellists using a 5-point Hedonic scale, and the data were analyzed using one-way ANOVA at $p>0.05$. The selected bar was coated with a dehydrated mixture containing 10% treacle and 90% buffalo curd. Proximate analysis was performed on the best-selected sample, and the nitrogen-filled, sealed-packed product was subjected to shelf-life analyzed over three months. Treatment 3, containing 5% mushroom powder, scored the highest in overall acceptability and was selected as the best formulation. The buffalo curd dressing completed the amino acid profile by providing essential amino acids like lysine and Sulphur-containing amino acids, which are typically lacking in plant proteins. Proximate analysis revealed moisture content at 9.77±0.17%, ash at 2.95±0.07%, crud fat at 23.2±0.65%, crud protein at 20.1±0.44%, and carbohydrate 43.98±0.10%. The energy content of the developed bar was 465.12 calories/100g. The final product has a high protein level more than twice that of the available commercial products. The shelf-life analysis found 1.45 x102 cfu/g of yeast and mold only during the 12-week, which is less than the necessary safety threshold. The developed nutrient bar demonstrated a higher protein content than commercially available products.

Keywords: Protein, underutilized, cereal bar, proximate analysis, chronic diseases, mushroom powder

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INTRODUCTION

Protein-rich diets, such as whey proteins, are high in amino acids and bioactive peptides, which help to control weight and increase feelings of fullness. (Akhavan et al., 2010). Consuming soy protein can also raise Peptide Tyrosine-Tyrosine (PYY). PYY is a hormone produced in the small intestine that reduces appetite and food intake, while also lowering ghrelin, a peptide hormone produced by the stomach, brain, and small intestine. Ghrelin, on the other hand, stimulates appetite, food intake, and fat storage (Konig et al., 2011). Cereal-based diets are increasing due to their health benefits and dietary fiber, antioxidants, vitamins, and minerals. However, cereals are deficient in essential amino acids and lysine, which can be improved by using legumes or pulses. There is a need for alternative protein sources to enhance protein content in cereal-based processed foods (Iqbal et al., 2006). Plant-based nutrient bars can be functionally enhanced by adding unique ingredients like mushroom powder, which can benefit glycemic control in diabetes. Oyster mushrooms, a commonly cultivated mushroom, can increase protein content and fiber content in dried powder (Maray et al., 2018). Plant proteins are lower in essential amino acids compared to animal proteins. Therefore, buffalo curd can help to replenish lacking amino acids (Hallqvist et al., 2019)

The main ingredients generally used to produce nutrition bars including soybeans, Soybeans carry 35.5g of protein out of 100g while Pumpkin seed's protein percentage is 34.56% (Habib, 2015), *Terminalia catappa* (kottamba/ Indian almond) has protein values of 21.98 to 22.44% (Jahurul et al., 2022), and sesame seeds range from 17–32%, with an average of roughly 25%.(Abbas et al., 2022).In addition, Soyabean extract has antioxidant values, with the IC 50, DPPH (426.51µg/mL), Pumpkin seed and with higher DPPH 67.99 ± 0.39, and a total antioxidant capacity of 30.61 ± 0.14. (mg/AAE/g) (Kaur, et al., 2020).

Protein bars are a convenient and convenient snack option for those who regularly exercise or engage in weight training. They contain a balanced blend of protein, carbohydrates, and fats, making them an ideal choice for those looking to increase their protein intake. Protein bars can help with appetite control and lower caloric intake, making them an ideal choice for weight management (Pal and Radavelli-Bagatini 2013); (Leidy et al., 2015). They come in various flavors and can be tailored to meet individual dietary needs. Nutrition bars are also a healthier alternative to junk foods, offering a quick and measured dose of nutrients. They are popular in sports and are convenient for the working population. The global market for nutritious energy bars has grown, with a wide range of bars available under various brand names. This study aimed to develop a protein-rich composite cereal bar with balanced nutrition and assess its shelf-stability. Protein bars are essential for weight loss and are a healthier alternative to unhealthy fast-food options.

METHODOLOGY

The main ingredient Soybean 30% added while 15% sesame, 15% desiccated coconut, 15% *T. catappa*, and 15% pumpkin seeds were added and 5% Raisins and dates from each. In addition, 30 ml of sweeteners (sugar syrup+ coconut treacle,) were added to the weight of 100 grams of solid ingredients. Soybeans were soaked for 12 hours and roasted in the oven for 125℃ at 90min, kottamba kernel were dehydrated for 18 hours at 60℃ and roasted for 20 min and ground for 2 minutes using a grinder. small particle size sesame seeds, desiccated coconut, pumpkin seeds, dates and raisins were dried for 5 min, at 175℃. Sugar syrup was heated to 80℃ , mixed with the ingredients and molded. Prepared bars were baked at 160-180℃ for 8 minutes in a preheated oven. Dried Oyster mushroom powder different percentages were added to the basic formulation according to weight, T1-0% Mushroom powder, T2-2% Mushroom powder, T3-5% Mushroom powder, T4-10% Mushroom powder and T5 Control -market available nutrient bar. The curd was dehydrated for 12 hours at 60℃

with 10% of the treacle. Dried curd drizzled on top of the nutrient bar to enhance the taste and add more protein. The final product was packaged in clear front/Silver back Stand-Up Pouches made of 48 ga PET, 2.5 mil LLDPE (Front), / 48 ga Metallized PET, and 2.5 mil LLDPE (Back). Nitrogen filling was done at 0.5 MPa pressure and packed. The sensory analysis of a developed nutrient bar was subjected to colour, flavor, aroma, appearance and texture using a 5-point hedonic scale using 30 untrained panelists. The pH and microbiology quality and shelf life were monitored over three months.

RESULTS AND DISCUSSION

Sensory attributes for the developed cereal bar are shown in Table 1. There was a significant difference in panelists' responses to taste, texture, and overall acceptability. T1, T2 and T3 showed significantly higher values for colour, taste, texture and overall acceptability compared to T4. T3 showed the highest ranks for appearance, texture, and colour ranks than T1, T2, T4, and T5.

Table 1. Sensory attributes for the developed cereal bar

Treatment	Appearance	Color	Taste	Texture	Aroma	Overall acceptability
T 1	**3.70±1.179^{a}**	**3.80±1.064^{a}**	3.53±1.137^{ab}	**3.50±1.225^{a}**	3.60±1.303^{ab}	3.63±1.159^{ab} (3)
T 2	3.63±1.189^{ab}	3.60±1.163^{ab}	3.60±1.037^{ab}	3.33±1.124^{ab}	3.70±1.055^{ab}	3.67±1.213^{ab} (2)
T 3	**3.90±1.029^{a}**	**3.93±1.015^{a}**	**4.13±1.008^{a}**	**3.80±1.095^{a}**	**3.83±1.053^{a}**	**4.00±1.174^{a} (1)**
T 4	2.83±1.053^{b}	2.43±0.917^{c}	2.60±0.894^{c}	2.57±1.040^{b}	2.93±0.944^{bc}	2.67±0.994^{c} (5)
T5	3.10±1.296^{ab}	2.93±1.202^{bc}	3.20±1.375^{bc}	3.00±1.462^{ab}	2.47±1.358^{c}	3.03±1.351^{bc} (4)

* Different superscript letters in the same column denote statistical difference at P<0.05
T1- 0%, T2- 2%, T3 5%, T4 10% of mushroom powder added bar and T5 market product

According to 1, T3 was the most favored sample performing well in all attributes containing 5% mushroom powder. A high composition of oyster mushroom powder 10% in T4 caused a burnt flavor in the mixture. Protein-nutrition snack bars have become popular due to their convenience and portability. One potential ingredient that can added to improve protein consumption is *Coprinus comatus* mushroom powder (Dimopoulou et al., 2023) which can be replaced with oyster mushrooms. Oyster mushrooms are farmed more frequently and have a mild flavor, making them suitable for various culinary traditions. Moisture content, ash, crude fat, crude protein, and carbohydrate of the product were 9.77±0.1755%, 2.95±0.068%, 23.2±0.6557%, 20.1±0.4359%, 43.98±0.1054%. respectively. The developed bar containing 20.1% protein content is slightly higher compared to the other similar nutrient bars. The developed nutrition bar contained 23.2% protein is much higher compared to the snack bar developed including *Coprinus comatus* powder and pea and *Coprinus comatus* powder, which had 18.8% and 19.5% protein respectively (Dilipkumar et al., 2020).

A meta-analysis of short-term Nitrogen balance studies in humans suggests that a healthy adult with little physical activity should consume 0.8 g protein/kg BW/day which is 60 grams of protein per day for 75 kg human (Rand, et al.,2003) which can be achieved by consuming 300 g of produced nutrient bar without depending other any food. According to the American Psychological Association (APA), adult women who are sedentary need an estimated 1,600–2,400 calories per day, while adult men need 2,000–3,000 calories per day. This nutrient bar carries 465.12 calories in 100 g. 20 bars of this product can give you high-calorie content. Therefore, moderate consumption of the developed bar could gain the required energy and proteins with other meals. Additionally, adequate dietary protein consumption can have a satiety effect and reduce food or energy intake, contributing to long-term regulation of white-fat accumulation and preservation of skeletal muscle mass.

Healthy adults can tolerate a dietary intake of 3.5 g protein/kg BW/day without experiencing adverse effects. However, safe upper limits for dietary protein intake have not been

established and can differ among individuals (Bilsborough and Mann, 2006) To achieve the daily minimum requirement and additional required amount of protein for athletes and energy high-energy requiring people to prevent abrupt overload of protein in various tissues, it is best to divide protein intake throughout the day, using nutrient bars as a great way to provide protein throughout the day. This developed nutrition bar can give a higher percentage of protein from the bar and can fulfill the satiety along the way.

Protein intolerance is a condition caused by an inadequate ability to digest or efficiently break down amino acids, which can cause food allergies when they are not properly digested (Flom,and Sichere, 2019). The developed bar contains milk protein and plant proteins which may cause allergies. The pH of samples during storage did not change significantly even after 12 weeks periods. During the eight-week storage period, no microbiological growth was found on the yeast and mold plates or total plate counts. However, after the 10^{th} week and 12^{th} week, yeast and mold colonies were detected at 3±0.58 cfu/g and 1.45 $x10^2$ cfu/g colonies respectively. The developed bar is free of preservatives which may cause to development of the yeast and mold after the 10^{th} week.

CONCLUSION

The developed high-protein nutrition bar contained milk proteins from dried curd, dried mushroom powder and plant proteins from the kottamba seeds, pumpkin seeds, and soybeans which are not highly consumed as whole grain. Treatment 3 having 5% mushroom powder was selected as the best sample. The development of yeast and mould during storage is the limiting factor for shelf life, though the product remained chemically and microbiologically safe and stable during the entire storage. It is recommended that further research be carried out to determine the possibility to enhance the shelf life and a market survey to prove consumer preference for the developed protein bar.

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