

## Millet Bars - Healthier Alternative to Cereal Bars - A Review

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### Review Article

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#### ABSTRACT

The demand for quality nutritious food is growing worldwide, that promote health and wellbeing for consumers and helps in reducing the risk for non-communicable diseases and improve the quality of life. The lifestyle changes of consumers, higher health consciousness and nuclear families has created the food industry to invent and innovate creative products by incorporating functional novel ingredients to enhance the nutrient quality and percent daily value per serving of the product. Millet-based bars are versatile products that can be developed as an alternate to existing cereal-based bars. However, technological constraints of manufacturing millet-based bars can be overcome by adding either hydrocolloids, enzymes, any pre-processed starches or by biofortification, genetic engineering or by introducing additional processing technique like fermentation. Incorporation of millets as major functional ingredient in snack food, especially in snack bar, helps to improve the nutritional attributes of the products and to overcome nutritional deficiencies at large.

### INTRODUCTION

There is an increasing demand in the global market for convenient and nutritious natural food products. Snack bars are commonly known as nutribars or granola bars is introduced into global market two decades ago. Owing to higher protein, fat, carbohydrate and mineral content, food bars are considered as food or snacks which provide good nutritional quality as well as sensory attributes<sup>[1]</sup>. To meet the demands of the growing market, there is an increasing necessity to innovate, improve or by modifying the composition of snack bars for additional health benefits<sup>[2]</sup>. These products can be modified to several extensions and can be used as supplementary or as food for special purpose<sup>[3]</sup>. Current changes in food industry is to develop high quality food using plant source which contain high nutritive profile<sup>[4]</sup>.

Concerns regarding food has increased among the consumers at different levels. Some prefers food which ensures lesser risk to the health throughout their life time while few prefer food that will not worsen the already existing health disease condition<sup>[5]</sup>. Foods consumed by school going children should contain high amount of vitamins, minerals, proteins, carbohydrates and fats. There are limited foods that provide wholesome nourishment to the young children. Therefore, utilising the emerging trends of nutraceutical and functional foods, this gap can be filled<sup>[6]</sup>.

#### Millets

Millets are crops that grow in semiarid zone of moderate rainfall and are generally regarded as annual warm weather grasses. It is widely found in tropical and subtropical regions of moderate rainfall in the world and grows within 3-4 months. The grain requires minimal energy relative to the more traditional crops<sup>[7]</sup>. Millets are accepted as functional foods and nutraceuticals due to dietary fibre, proteins, minerals, vitamins and antioxidants<sup>[8]</sup>. Millets are alkaline food which helps in maintaining the pH balance in the body to prevent illness<sup>[9]</sup>. The content of crude fibre in sorghum and millets ranges from 2-11.9% whereas dietary fibre content ranges from 2.2-28.5%<sup>[10]</sup>. Sorghum and millet composed mainly of insoluble dietary fibre and contributes significantly to the antioxidant activity as it contains high levels of phenolic acids and polyphenols. It was also reported that consumption of food that contain these grains decrease gastrointestinal transit time, prevent gastrointestinal problems and slow glucose release into the blood stream.

Millets are found to exhibit superior nutrient availability in comparison to cereals and are cost effective. They contain nearly 70% of starch as polysaccharide, which contributes to slow digestion than cereals. Despite its excellent nutrient profile, these crops are not popular and are underutilized in India<sup>[11]</sup>. Knowledge regarding physical properties of millets is required to construct a suitable processing technique, to develop innovative products and also to retain its quality throughout storage<sup>[12]</sup>.

In millets, 51-78% of grain weight is represented by starch granules. The native starch granules of millets are pseudo-crystals which makes them insoluble in cold water, exhibit birefringence and are inaccessible to enzyme attack. Starch contributes energy that is required for seed germination [13]. Pearl millet contains starch granules which are loosely packed in a discontinuous protein matrix and also has high water holding capacity and higher swelling power and solubility than other [14,15]. Foxtail millet and proso millet has starch compound which are less soluble and has higher water binding capacity than wheat starch [16].

Protein content of millets depends upon agronomic and environmental conditions like water availability, temperature and fertility as well as genotype. Millets contain higher amount of protein when compared with other cereals due to their higher germ to endosperm ratio. This property also improves amino acid composition. Prolamines and glutelins are two predominant protein fractions in millets and they lack lysine which is similar to cereal.

In general, phenolic compounds have the ability to donate hydrogen atom which helps them to act as antioxidants. Phenolic compounds present in plants can function as metal chelators, singlet oxygen quenchers and reducing agents [17]. Millets contain high amount of p-coumaric and ferulic acid among other phenolics. These compounds act as antiviral, anticancer, antiplatelet aggression, antimicrobial and anti-inflammatory [18].

They reported the whole millet acts as anti-oxidants, chelating agents and help in risk of disease reduction [19]. Intake of whole grain foods are beneficial for the prevention and management of diabetes mellitus. A low incidence of diabetes was found in millet consumers [20].  $\alpha$ -glucosidase and pancrealitic amylase reduces the postprandial activity of hypoglycaemia by inhibiting the enzymatic hydrolysis of carbohydrates.

Millets contain higher amount of fibre and sugars and indicate relatively low glycaemic index and helps in lowering glucose levels [21]. Several experimental studies showed reduced risk of CVD due to consumption of whole grains [22]. Millet grains are known as anti-nutrients which help in reduction of breast and colon cancer [23]. Millets which is rich in antioxidants and phenols, help to delay aging and metabolic syndrome. It also showed that methanolic extracts of kodo millet and finger millet inhibits glycation and collagen linkage [24]. Effects of anxiety, depression, insomnia, migraine and heart attack can be reduced due to good amount of magnesium present in millets. Finger millet helps in reducing the appetite, because of tryptophan content. Vitamin C helps in the absorption of iron and helps in treating anaemic patients.

Millets help in reducing plasma non-HDL and liver cholesteryl ester concentration and increased faecal concentration [25]. Foxtail millet protein hydrolysates lowered blood pressure significantly and decreases angiotensin converting enzyme activity [26]. Extracts from various millets had shown inhibition against proliferation of human colon cancer cell (HT-29) and radial-induced supercoiled DNA scission by 28-100%. Phenolic extracts exhibited inhibition of human breast cancer cells proliferation and against human liver cancer cells in a dose-dependent manner [27]. They had found greater inhibitory activity of acidified methanol phenolic extracts against  $\alpha$ -glucosidase than  $\alpha$ -amylase [28]. It found that finger millet whole grain and bran had increased levels of reduced glutathione and catalase in liver and decreased the levels of lipid peroxide, nitrite and superoxide dismutase [29].

### **Snack bars**

Eating habits cause several nutrition related problems like consuming low ingestion of fibre leads to several gut related problems among youth and adults. Therefore, regular consumption of dietary fibre, which has high indigestible factor, is recommended among youth and adults to maintain healthy gut. This in turn contributes to significant modification in prevention of several chronic diseases. Formulating snack bars using regional raw materials will be sensational from nutritional as well as in sensory perspective, as these can be considered as an option in menu of the particular region. This kind of foods earns profit in global market as an innovative food [30].

Energy bars are dietary supplements and mostly consumed by people who want to maintain calorific needs. It also provides protein, fat and high concentration of carbohydrate [31]. Wholegrains based diets are increasing day by day because of its good source of dietary fibre, antioxidants, vitamins, etc., but protein quality is poor as it is deficient in essential amino acids, especially lysine. Cereal-bars can be incorporated with different ingredients, such as whole cereals, almonds, chestnuts, nuts, dehydrated or crystallized fruits, chocolates, sugar, candies, etc. along with other processed cereals [32]. The ingredients that are used should be added appropriately to assure common physical characteristics, flavor and texture as concerned, principally the balance point of water activity [33]. The nutritious bars have earned importance and popularity in the market today. Energy bars provide most of their food energy (calories) in carbohydrate form [34].

Protein bars are usually lower in carbs than energy bars, lower in vitamins and dietary minerals than meal replacement bars, and significantly higher in protein than other types of bars. Protein bars are mainly used by athletes or exercise enthusiasts for muscle building. Body requirement for protein is higher and can be easily supplemented with protein bars. Oats, peanuts, soybean flour, amaranth, protein isolates and concentrates, etc., are generally used ingredients in making protein bars. Some of the processing techniques reduces the bioavailability of the protein compounds. Therefore, processing of the ingredients used acts as an important criterion during selection of ingredients to make nutrition bars. The protein rich nutribars should be appealing and satisfying to the consumers. Apart from being nutritious, they should have appreciable flavour and texture [35].

High fibre bar provides fibre content of nearly 8-10 gm / 50 gm of bar. Irrespective of being rich in fibre, it also contains energy value of about 100 kcal per unit [36]. Fibre has many beneficial effects on one's health, especially for cardiovascular and diabetes patients. Major attributes of fibre that contribute to better health are its ability to decrease total cholesterol, reduces the

accumulation of LDL cholesterol and triglyceride level as well. It was also reported that people with diabetes who consumed high fibre diet had lower serum glucose level compared to those who had low fibre diet [37].

The nutrient, snack or cereal bars can also be classified into three main categories, according to a report in USA regarding the snack food consumption. They are health and wellness snack, energy and nutrient bars and organic snack bars. When the focus is on consumption behaviour, it can be classified as a replacement for a meal, or as a part of meal (as a food eaten between two main meals, or as a part of breakfast, lunch or dinner) or as a dessert (after a meal) [38]. They have categorized snack bar types: fruit-based snack bar, wheat or soy-based snack bar, cereal based snack bar, vegetable-based snack bar and high protein snack bar.

According to Global Sweetener Development Group, New Jersey (2015), classified snack bars into high protein bars, protein bars, balanced carbohydrate/protein/fat and high carbohydrate bars. High protein bars are usually used in high protein programs as a supplementary food or used by body builders as a protein supplement. It contains 130-230 calories, 16-20 gm of protein, 5-10 gm of fat, and 15-25 gm of carbohydrates per 50 gm of the product. Protein bars contain slightly lesser amount of protein in comparison with high protein bars and provides 180-240 calories, 10-15 gm of protein, 5-15 gm of fat and 15-25 gm of carbohydrates per 50 gm. Dan and Labuza have indicated proportion of ingredients for protein based snack bars as soy/dairy proteins (20-40%), fats (10-15%) and carbohydrates as sugar syrups (10-50%) [39,40]. Flavorants and stabilizers are added to basic ingredients for protein bars. Balanced carbohydrate/protein/fat bar is designed with a goal to provide balanced nutrient. Bars that contribute approximately 5-10 gm of protein, 5-20 gm of fat, 20-30 gm of carbohydrates and 200-275 calories per 50 gm of bar falls under this category. High carbohydrate bar is developed in order to provide sustained energy or provide immediate energy. It provides nearly 160-230 calories, 30-40 gm of carbohydrate, 2-9 gm of protein and 5-15 gm of fat per 50 gm of the product.

According to the bars are classified into high-protein bars, balanced nutrition bars, low carbohydrate bars and grain-based bar [41]. Balanced nutrition bar is also called 40-30-30, as it is formulated to provide 40%, 30%, 30% of energy from carbohydrates, protein and fat respectively. It approximately contributes to 5-10 gm of protein, 20-30 gm of carbohydrates, 5-20 gm of fat and 200-275 calories per 50 gm of the bar. High protein bars contain highest level of protein than any other bar. Low carbohydrate bars are formulated to minimize carbohydrates and maximize protein. This bar should contain protein content of balanced nutrition and high-protein bar. These kinds of bars are formed using high levels of sugar alcohols, fibre and non-nutritive sweeteners to achieve the net carbohydrate. Grain based bars contain wholegrain as their main ingredient and will have low protein content. A typical cereal bar contains a fruit filling and an outer coating made up of cereals. It often contains 8% fat, 2.5% protein, 2.5% fibre and 73% carbohydrate.

A variety of ingredients have been used in the preparation of snack bar. This aids in catering to the diet requirements of a varied number of people, who look forward to a healthier lifestyle. As there is growing demand for food with more health benefits, bars are developed with ingredients that is nutritional as well as functional. Cereal bars are also called as portable nutrition as it provides good quantity of carbohydrate and promotes energy recovery after strenuous exercise [42].

### **Technological constraints and opportunities of utilising millets in snack bars**

There are certain opportunities and challenges in using millets due to their nutrient composition like dietary fibre, health promoting phytochemicals, resistant starch, vitamins and minerals and have additional anti-nutrients which makes it a challenge to utilize them in making varied snack products [43,44]. Tannin is an antinutritional compound which inhibits the fermentation process by binding to protein and condensed tannins alter the colour, texture and taste of the end product [45]. Grains, that are processed either into small sized grains or into flours, affects the end product by giving low volume or by causing rancidity [46]. Gluten proteins help in forming the cohesive viscoelastic dough, wherein absence of this protein does not provide a proper structure to the product. Proteins present in millets do not contribute to the texture of product in comparison to wheat protein. Owing to higher dietary fibre content, millets affect the crumb structure, colour and texture of the product.

The main challenge in making a nutrition or snack bar is getting an appropriate texture of the bar apart from meeting the required nutrient content. There are several physical, chemical, thermo-dynamical and process related factors that affect the texture of the bar. They reported that insoluble aggregates that are formed during intercharge reaction between thiol-disulfide results in bar hardening. It was also reported that an increase in water activity of the product does not soften the bar alone, sometimes it also hardens the bar [47]. This is due to the reduction in water available for plasticizing of the protein particles. A challenge in making high protein bar is to maintain its taste and texture along with its bioavailable protein.

Millets can be combined with legumes and certain oil seeds in preparation of snack bars by using appropriate processing technique. There are several strategies that are proposed in order to utilize these millets in production of gluten free products that are mostly dough based. The strategies involve either reformulation of the product using hydrocolloids, enzymes, additives, pregelatinized and native starches and flours, germinated flours and by adding other non-cereal gluten-free ingredients or by altering the processing technique or by breeding or genetic engineering.

Using hydrocolloids like xanthan gum or cellulose derivatives increased gas retention, improved texture, delayed staling of bread, low resistance to deformation, increased viscosity of batters and improved crumb texture [48,49]. Emulsifiers help in higher elastic recovery, staling rate has been reduced and spread ratio of cookies has been improved by adding wheat flour lipids [50]. Use of pregelatinized starches increases the viscosity of the batter with increase in starch concentration, increases cohesiveness and

elasticity of the crumb but also increases crumb damage. Therefore, appropriate proportion of the ingredients should be needed. Germinated flours can also be used as it was found to decrease hardness and increased cohesiveness and it also helps in designing new foods [51].

Fermentation of the flour improves the nutrient composition, reduces antinutrient content and improves cooking property along with protein degradation and synthesis of oligosaccharides [52,53]. Precooking of the dough prior to the extrusion changes the properties of dough which yields a good quality product. Hydrothermal processing also results in enhanced carbohydrate and protein digestibility of the flour. Fermentation and heat-moisture treatment improve starches that digest slow and resistant starch content of the flours [54].

Biofortification of sorghum using genetic engineering led to starch with high protein and starch digestibility [55]. By introducing genetically modified sorghum improved lysine content and protein digestibility [56-58].

## CONCLUSION

Millets are grains with high nutritive value. They can be used to make foods that are of therapeutic use. When ones eating habit changes, it represents a change in one's health condition. Due to lack of several technological constraints and challenges, the utilization of the millets is lower in several countries. Being a cost-effective crop, this can be used to make products that are low cost and highly nutritious. Snack bars are on the go food products which is eaten as a part of meal or replacement for a meal. When these bars are made up of millets, additional health benefits can be attained. This can be helpful to fill the gaps in current nutrition related problems.

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