

CHAPTER II

LITERATURE REVIEW

2.1 Ingredient Review

2.1.1 Sorghum

Sorghum (*Sorghum bicolor L.*) is one example of a cereal that contains dietary fiber essential for the body and can have positive effects on health, it is shown in table 2.1. In Indonesia, sorghum is processed as a substitute for white rice because it has relatively high nutrients such as carbohydrates, fats, and protein. The protein content in sorghum is higher compared to other cereals such as maize, rice, millet, and others. The high nutritional content in sorghum cereals makes it a crucial immunonutrient for improving public health (Rajeswari *et al.*, 2023).



Figure 2.1 Sorghum

Sorghum also contains phenolic compounds known to have antioxidant and antitumor activities, and can inhibit viral development, thereby reducing the risk of diseases (Rajeswari *et al.*, 2023). Additionally, in terms of cultivation, sorghum is highly tolerant and easily adaptable to dry and extreme climate conditions, with minimal maintenance requirements, making it suitable for cultivation in Indonesia.

Sorghum is basically composed of starch, which is more slowly digested than that of other cereals, has low digestibility proteins and

unsaturated lipids, and is a source of some minerals and vitamins (Cardoso *et al.*, 2016). Being devoid of gluten, sorghum provides a nutritious option for individuals grappling with celiac disease or gluten intolerance. Its usage transcends food categories, from cereals and snacks to pastries and beverages, substantiating its attribute of versatility (Tanwar *et al.*, 2023)

Ripe sorghum seed is partially enclosed by glumes that are removed during threshing or harvesting. The seeds are oval to round shaped and may be red, white, yellow or brown in colour and are made up of testa, embryo and endosperm (Muindi *et al.*, 2023). Sorghum has great potential as a functional and sustainable food that can be used in daily meals as a substitute for common cereals like wheat, rice and corn. The studies in the review show that it is possible to process sorghum in a wide variety of ways to obtain ready-to-eat products and ingredients for food products and preparations, such as popping, lamination, extrusion and wet cooking (Aguiar *et al.*, 2023). The detail of nutritional composition sorghum is presented in the Table 2.1.

Table 2.1 Nutritional composition sorghum (Tanwar *et al.*, 2023)

Component	Content
Macronutrients (%)	
Carbohydrates	70–80
Protein	8–18
Lipids	1–5
Dietary fiber	19
Crude Fiber	3
Mineral (µg/g)	
Calcium	132
Potassium	2874
Magnesium	1496
Phosphorus	286
Vitamins (mg/100 g)	
Niacin	2.927
Riboflavin	0.142
Thiamin	0.237
Vitamin B-6	0.590
Vitamin E	0.810

2.1.2 Sorghum Sugar

As is widely known, before being processed into sugar, the crop first takes the form of sugar syrup, a thick liquid product. Crops used for sugar production include sweet sorghum and sugarcane. Sweet sorghum (*Sorghum bicolor* [L.] Moench) is known for its high biomass and sugar production in its stem juice. Where, sorghum sugar or sweet sorghum comes from 100% sorghum stem juice which is taken. It is then heated until it thickens and crystallizes, then dried. Sweet sorghum (*Sorghum bicolor* [L.] Moench) is a crop that can be grown in various agroclimatic conditions and production systems with minimal inputs (Sandin et al., 2021). It is characterized by high biomass production and stem sugar accumulation, indicating significant bioenergy potential.

The reason for using sweet sorghum is that it has a lower sugar content compared to sugarcane. This was proven in the research of Asikin et al. (2017), where the total sugar content of sugarcane was higher at 80.52 grams compared to sweet sorghum at 68.57 grams per 100 grams. Thus, sugarcane syrup has a sweeter taste than sweet sorghum syrup. In contrast, sweet sorghum syrup showed significantly higher salty and bitter flavor characteristics compared to sugarcane syrup. This is due to the higher concentration of minerals, especially potassium, calcium, and sodium, as well as total organic acids in sweet sorghum syrup. Furthermore, sweet sorghum syrup also contains a much higher total phenolic content compared to sugarcane syrup. These phenolic contents are known to have antioxidant activity, which can help prevent the risk of developing diseases (Asikin et al., 2017). The detail of nutritional composition comparison between sweet sorghum and sugarcane is presented in the Table 2.2

Table 2.2 Comparison of sweet sorghum and sugarcane component (Asikin *et al.*, 2017)

Component	Sweet Sorghum	Sugarcane
Sugars (g/100g)		
Glucose	10.88	1.02
Fructose	5.56	0.98
Sucrose	52.13	78.53
Total sugars	68.57	80.53
Organic acids (mg/100 g)		
Aconitic acid	2312.87	159.71
Malic acid	468.09	12.69
Citric acid	378.41	94.54
Succinic acid	20.3	n.d
Total organic acids	3179.67	266.94
Major minerals (mg/100 g)		
Potassium	3928.89	661.85
Calcium	441.12	18.39
Magnesium	88.28	77.76
Phosphorus	40.60	61.02
Sodium	91.85	21.56
Minor minerals (mg/100 g)		
Iron	0.27	0.16
Aluminum	0.39	0.15
Zinc	1.25	0.08
Manganese	0.54	0.54
Copper	0.55	0.08
Chromium	0.35	n.d
Total minerals	4594.34	841.98

2.1.3 Condiment Ingredients

- Dried Mix Raisins

Raisins are a processed product made from dried grapes. Raisins contain phytochemicals and dietary fiber that contribute to maintaining health. The health benefits of raisins include helping to lower the risk of coronary heart disease, reducing the risk of metabolic syndrome, improving intestinal function, and reducing bile acid levels

(Wijayabahu *et al.*, 2019). Unlike fresh grapes, raisins have additional benefits due to their phytochemical content, such as phenolic acids and tartaric acid. According to Wijayabahu *et al.*, (2019), these phenolic compounds can act as good dietary antioxidants, helping to minimize the risk of degenerative diseases.

- **Dried Dates**

Dried dates are dates that have undergone a drying process. Dates (*Phoenix dactylifera*) are a species from the *Arecaceae* family that are rich in benefits, containing many essential nutrients and polyphenols, and are among the most commonly consumed fruits in the Middle East and North Africa. Dates offer numerous health benefits, including antioxidant, anti-inflammatory, and anticancer activities, an addition improving vascular health (Al-Dashti *et al.*, 2021). Additionally, dates are rich in dietary fiber such as pectin, hemicellulose, lignin, resistant starch, and soluble fiber.

- **Chia Seeds**

Chia seeds are grains derived from the plant *Salvia hispanica L.* Among the species of the genus *Salvia*, chia (*Salvia hispanica L.*) stands out as a shrub approximately 2 mm in size, notable for its high nutritional and functional value. Chia seeds are typically consumed in the form of flour and whole seeds, which can be added to preparations such as fruit, yogurt, cakes, and other dishes. The health benefits of chia seeds include aiding in the management of obesity, cardiovascular diseases, diabetes, and certain types of cancer. Chia seeds are rich in essential fatty acids, dietary fiber, antioxidants, flavonoids, anthocyanins, vitamins, carotenoids, and minerals (Silva *et al.*, 2016)

2.2 Product Review



Figure 2.2 Snack Bar

Sorghum snack bar is a snack bar containing pop-sorghum, mixed raisins, dried dates, chia seeds, and sorghum sugar caramel. The reason sorghum is processed into snack bars is because snack bars are compact bar-shaped snacks and are usually made from cereals or nuts, and can also include fruits that are easily portable, so they are easy to consume without requiring special conditions (Suloi et al., 2020). Healthy snack bars provide nutritional advantages or benefits to the body and are attractive as food. Nutrition bars have become a solution for lunch boxes, quick breakfasts on the bus, and after-school snacks. Not only are bars popular for their portability, but they have also become popular for the health connotations associated with them (Soni et al., 2018). Conventional snack bars sold in retail outlets are usually made with honey or sugar and glucose syrup. As honey can be an allergen, food product developers have been looking for ways to replace honey with other non-allergenic ingredients (Ibrahim et al., 2021). One way is to replace honey with sorghum sugar, as was done in this study. Meanwhile, the disadvantage of this sorghum snack bar is that it is difficult to be consumed by elderly people, because the texture of this sorghum snack bar is crunchy and slightly hard, so this product is more recommended for consumers of productive age.

2.3 Process Review

There are three processes involved in making sorghum snack bars, popping the sorghum, caramelizing the pop-sorghum and the sorghum snack bar, and drying the dates using a dehydrator.

2.3.1 Pop-Sorghum Process

As is commonly understood, corn can be processed into a snack called "popcorn." However, not only corn can be processed into popcorn, but similar cereal plants, such as sorghum seeds, can also be made into a similar snack, referred to in this case as "pop-sorghum." The process of making pop-sorghum is called popping, which produces a honeycomb-like structure in the sorghum. There are several techniques for popping, including using a pan, a microwave, and dry heat (Campos *et al.*, 2021). Pan popping has advantages over other methods in terms of control over ingredients and the texture produced. Using a pan, the maker can determine the type and amount of oil, butter, and seasonings used, making it healthier and more customizable. Additionally, the texture produced is superior compared to other methods such as microwave popping.

2.3.2 Caramelization Process

Caramelization is the process of heating sugar to produce a brown color and characteristic caramel flavor that is most widely used in the food industry as a natural colorant, flavor, and antioxidant (Jafary *et al.*, 2018). The caramelization process needs to be carried out in the manufacture of sorghum snack bars because it increases product durability. The resulting caramel has antioxidant activity that depends on pH and the type of sugar used in the reaction (Zadeh *et al.*, 2020). In the caramelization process, this study was conducted twice, the first caramelization for pop-sorghum, and the second caramelization to bind all sorghum snack bar ingredients. Usually caramel is made with granulated sugar, but in this study sorghum sugar was used.

2.3.3 Drying Dates Process

The dates used are Tunisian stem dates. Since the dates already had a relatively dry texture, they were cut into small pieces to speed up the

drying process. The dates were then dried using a dehydrator at 60°C for 3 hours. This is in accordance with research conducted by Fatchullah, et al. (2022) who found that effective drying occurs at temperatures between 50°C and 60°C with a drying time of 2 to 3 hours. As a result, after drying, the dates become drier but still have a chewy texture that is good for consumption. This result is the goal of this drying process, which is to reduce the water content and increase the chewiness of the texture of the dates. So that the product becomes durable and more delicious to consume.