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Biological Activities of *Beng-tigré (Vigna radiata)*: Nutritional Aspects and Therapeutic Functions

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Abstract -*Beng-tigré* is a variety of *Vigna radiata*, a legume of the Fabaceae's family newly introduced in Burkina Faso for its resilience to the effects of climate change, its high nutritional value and its potential to reduce the prevalence of chronic diseases in the population. The objective of this study was to raise awareness of the nutritional and therapeutic qualities of *Beng-tigré* seeds among the Burkinabe population. A legume that matures between 55 and 70 days, *Beng-tigré* has a high nutritional value influenced by processing methods such as germination, fermentation and cooking time. Well consumed in Asia for its high protein (23.50g), fibre (16.80g), and carbohydrate (62.75g) content, as well as its high vitamin and mineral content, *Beng-tigré* is used as a supplement in the preparation of weaning foods and contributes to the fight against malnutrition in infants and young children. Rich in polyphenols, polysaccharides and peptides, *Beng-tigré* is a functional food that can contribute to the prevention and management of certain degenerative diseases. Several in vitro studies and studies on laboratory animals have shown the anti-cancer, anti-diabetic and anti-hypertensive effect of *Beng-tigré*. It also acts as a prebiotic to maintain the homeostasis and functions of the intestinal microbiota. A functional food with multiple virtues, *Beng-tigré* can be of great use in preventive medicine in developing countries where chronic non-communicable diseases are rampant. Further studies are needed at the local level to better understand the synergistic effects of the multiple components of *Beng-tigré* and to ensure therapeutic convenience for the population.

Keywords: *Beng-tigré, legumes, bioactive molecules, benefits, health*

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1. Introduction

The plants that are of most interest in solving the problem of food and therapeutic deficiency in the world, particularly in Africa, belong to the order of legumes [1]. According to the World Health Organization (WHO), pulses and cereals are important sources of macronutrients and micronutrients [2]. Pulses are usually used in the formulation of functional foods with health benefits for the consumers [3]. Their seeds are characterized by high energy and nutrient density. Among these legumes, *Vigna radiata*, which originates from Asia, is grown mainly in Thailand, Burma, Indonesia and the Philippines, but is less known in Africa [4].

These legumes are used in the production of many dishes. For example, it can be eaten cooked, alone, or with other cereals, sprouted or fermented [5]. Considered the main producer of *Vigna radiata*, Asia has about six million hectares for its exploitation; with a production of about three million tons per year, which is processed and consumed as porridge, sprouts, or high value-added noodles [6]. A tropical plant of the *Fabaceae's* family, *Vigna radiata* is widely consumed in households in Pakistan, often with cereals to optimize the nutritional quality of meals [7]. It is now widely grown in South America, Australia and the United States [8,9]. In Africa, it is mainly cultivated in three regions, namely West, Central and Southern Africa [10]. Because of its nutrients content, *Vigna radiata* can be used as a weaning food [11,12,13]. Its starch would be more digestible than that of other legumes and better tolerated by children because it induces less flatulence [14,15]. [16] showed that *Vigna radiata* contains less anti-nutritional substances than snow peas, soybeans and cereals. Rich in bioactive compounds, various therapeutic virtues have been attributed to *Vigna radiata* by several authors [17,18,19]. Called *haricot mungo* in French, Mung bean in English, or *Beng-tigré* in Mooré language, although cultivated in many African countries, it remains very poorly known and is slow to be integrated into the dietary habits of African populations.

In some countries such as Kenya, it is mainly cultivated for commercialization [20].

Recently introduced in Burkina Faso, only one variety of *Beng-tigré* is cultivated in the country with 49 accessions available. The efforts of the national champion for nutrition in Burkina Faso to introduce *Beng-tigré* into household food habits requires the support of the scientific world, in this case to explain its virtues and benefits. Several efforts are being made to create variety of *Beng-tigré*-derived dishes available to consumers through the Burkimbi-bara association. Couscous, pasta, lumps, biscuits, chips, bread, plain juice or with ginger (*Zingiber officinale*) or bissap (*Hibiscus sabdariffa*) and liquor are the different type of by-product that could be produced. The quality of its nutritional composition inspires the promoter of this crop. *Larlé Naaba Tigré*, known as national champion for nutrition in Burkina Faso, has decided its popularization in order to fight hunger and multi-deficiency malnutrition in the country.

This culture is encountering difficulties in introducing itself into the eating habits of Burkinabe. Thus, the *Burkinbi-bara* association in Burkina Faso works for the integration of this legume in school, university and hospital canteens. *Beng-tigré* is an orphan crop in Burkina Faso according to the research structure *Institut de l'Environnement et de Recherches Agricoles* [21]. Therefore, there is no available scientific data on it that could support its valorisation.

This study aims to assess the state of scientific knowledge on the nutritional and functional properties of *Beng-tigré*.

2. Biology and Ecology of *Beng-tigré*

A tropical plant native to Asia [22,23], *Beng-tigré* is a legume closely related to Ciebe and Adzuki according to genus [24]. The phylogenetic classification of *Vigna radiata* is as follows: Kingdom: Plantae; Subkingdom: Tracheobionta (Vascular plants); Superdivision: Spermaphyta (Seed plants); Division: Magnoliophyta (Flowering plants); Class: Magnoliopsida (Dicotyledons); Subclass: Rosidae; Order: Fabales; Family: Fabaceae (Pea family) and Genus: *Vigna radiata* (L.) (Mung bean) [24,25].

2.1. Description of *Beng-tigré* Plant

Erect to semi-erect, *Beng-tigré* is a slightly pubescent, epigeous germinating plant of up to 1.3 m high with a pivoting root system and a branched stem that curls up at the end. The leaves of *Beng-tigré* are dark green, alternating with three to five leaflets and bisexual flowers according to Figure 1 [26]. Seeds measure between 2.5 - 4 mm long and 2.5 - 3 mm wide.

The Asian food encyclopaedia listed approximately 2000 varieties of *Beng-tigré* [27]. Depending on the colour of the seeds, there are two types of cultivars. Those with a golden-yellow grain, often grown for fodder or as a green manure, it has a low yield; and other with a green grain, lively, more prolific, ripening more uniformly, whose pods are less prone to shelling [26]. In Burkina Faso, only one variety of *Beng-tigré* is cultivated and 49 accessions are available [21].

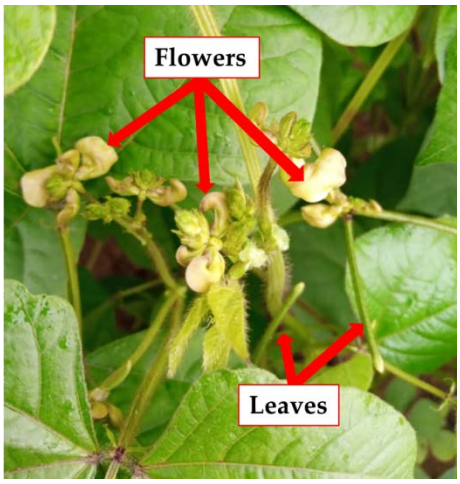

Figure 1. Flowers and leaves of *Beng-tigré* plant

2.2. Plant Ecology and Growth

Beng-tigré grows on many types of soils, with a preference for well-drained silty soils or sandy loam. A warm-season plant, *Beng-tigré* grows mainly at average temperatures between 20-40°C, with an optimal temperature of 28-30°C **[26]**. *Beng-tigré* is a drought-resistant legume, and is more resistant to the effects of climate change through relatively short seasons; it matures between 55 and 70 days [28]. In most cases, *Beng-tigré* can be sown twice during the crop cycle and once in the off-season [26]. It grows faster compared to other summer legumes, such as *Vigna unguiculata* [23,29].

2.3. *Beng-tigré* Harvest and Yield

Beng-tigré is usually harvested when the pods begin to darken. Harvesting is usually handily done, about 2 to 5 time a week. The average yield of *Beng-tigré* is around 300-700 kg/ha. Under irrigation, a yield of 1.25 t/ha has been recorded in Kenya. Under optimal conditions during trials, yields above 3 t/ha were obtained [26].

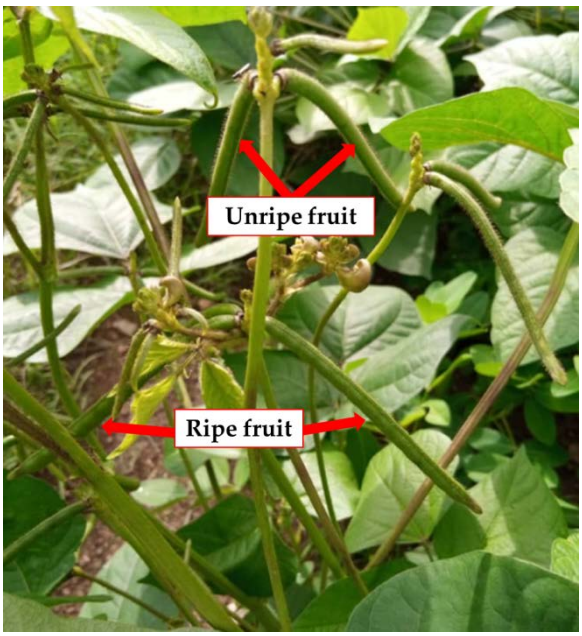

Figure 2. Ripe and unripe fruits of *Beng-tigré* plant

3. Nutritional Properties of *Beng-tigré*

3.1. Nutritional Content of Beng-tigré

Beng-tigré is commonly used in food in association with cereals to increase the amino acid, vitamin and mineral content of diets [30,31]. Because of its content in protein, dietary fibre, minerals and essential amino acids as well as its hypoallergenic properties, it is used as a supplement in the preparation of weaning foods [11,12,13]. It's an iron source for several households in Pakistan [7]. Figure 3 below gives an average of the macronutrient composition of the fresh material of the whole seeds of *Beng-tigré* per 100g according to [11,32], and [33], data sheet.

3.2. Impact of the Technological Processes on the Macronutrients Content of *Beng-tigré*

Several processing methods can be applied to *Beng-tigré*, namely cooking, germination and fermentation in order to vary culinary recipes. These different processes have an impact on the macronutrient content of *Beng-tigré* according to several authors [5,32,34]. According to Figure 4, *Beng-tigré* sprouts are low in fibre, protein, carbohydrates and lipid. The fermentation process increases the content in lipids and proteins (Figure 4).

Non-thermal processes as germination and fermentation significantly influence the contents in many nutrients. Cooking process also affects the nutrient content of *Beng-tigré* seeds. According to [31], the temperature and cooking time significantly influence the nutrient content of *Beng-tigré* seeds. For temperatures above 90°C with a cooking time of more than 30 minutes, there is a significant reduction in carbohydrates and proteins content. While for temperatures below 90°C, only the cooking time influences the nutrient content of *Beng-tigré* seeds. At this temperature (90°C), the cooking time must be less than 60 minutes to preserve the nutritional composition of the seeds [4]. Figure 5 shows the influence of temperature and cooking time on the nutrients contained in *Beng-tigré* seed.

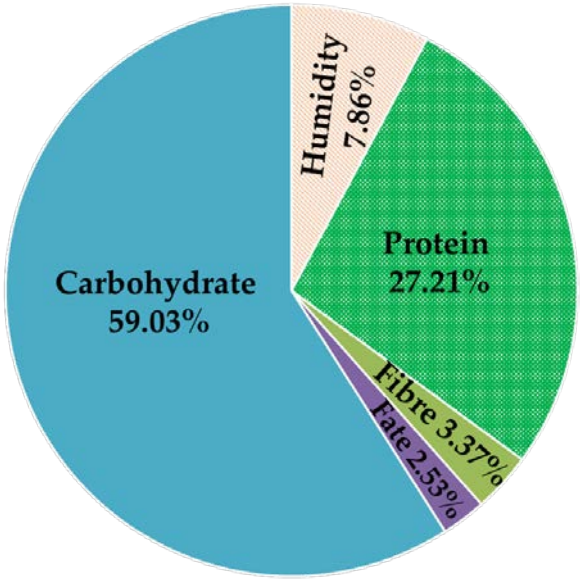

Figure 3. Mean macronutrient composition of fresh *Mung bean* seeds

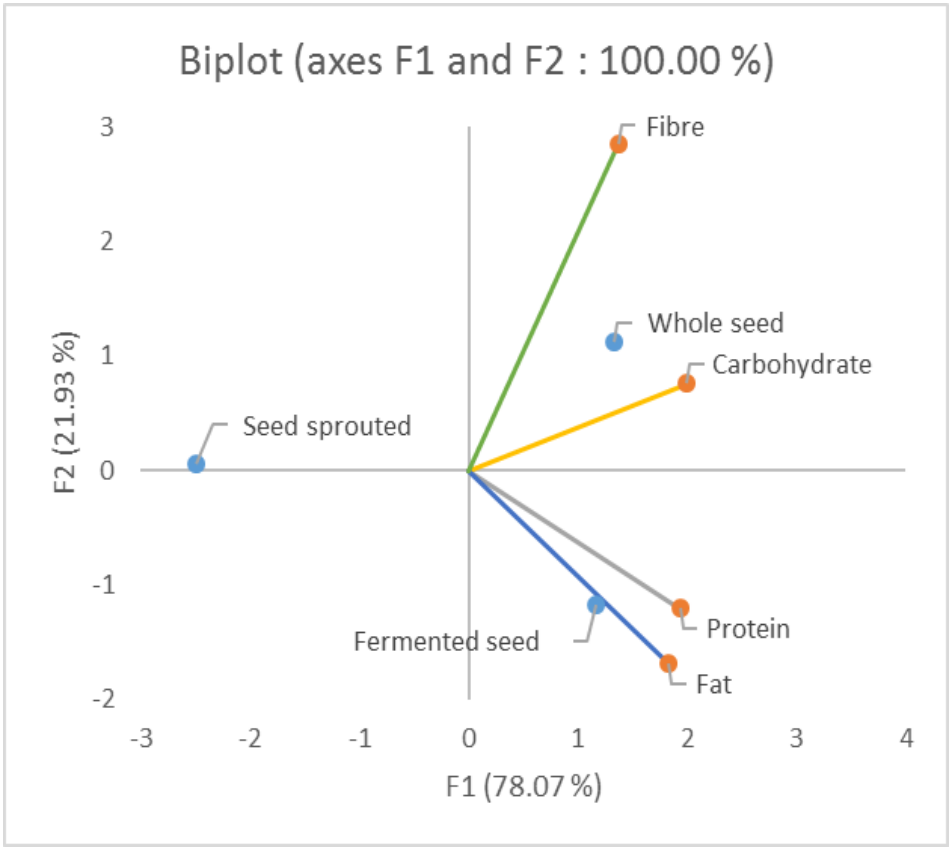

Figure 4. Principal component analysis of *Beng-tigré* dry seeds

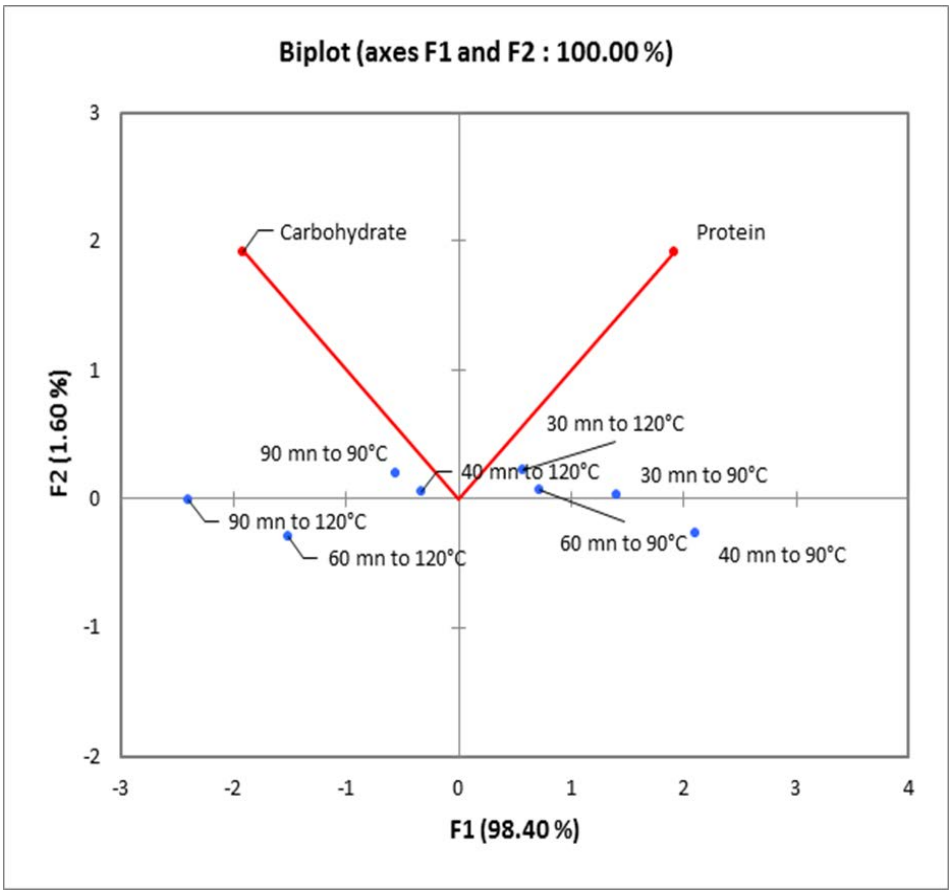

Figure 5. Principal component analysis of the influence of cooking (temperature and time) on seed composition

4. Micronutrient Composition of *Beng-tigré*

Several authors have reported that *Beng-tigré* is very rich in nutrients and could contribute to reducing micronutrient malnutrition suffered by more than half of the world's population, particularly women and adolescents of reproductive age [11,35,36]. Improved varieties of *Beng-tigré* are reported to have a higher level of iron (60mg/kg) than traditional varieties (30 up to 35mg/kg). [36,37,38] also reported an iron content ranged from 35 to 87 mg/Kg of fresh material. According to the same source, the consumption of 100g of *Beng-tigré* in the daily ration provides about 46 to 109% and 19 to 48% of the recommended daily iron intake for men and women respectively. [39,40] and [41] reported that agronomic, soil and weather factors have an impact on the iron content of *Beng-tigré* seeds. Studies conducted in Egypt and India reported widely disparate levels of Calcium (840 to 5170 mg/kg), Potassium (36 to 14100 mg/kg), Sodium (120 to 134mg/Kg) and Phosphorus (3910 to 5170 mg/kg) [11,36]. This significant difference in the mineral content could be explained by the variety grown, the soil composition, and other growing conditions such as the use of fertilizers and mineral content of waters. Phytic acid considered as an anti-nutrient compound that can influence mineral bioavailability has a low level in *Beng-tigré* (2.7 up to3.9g/kg) compared to other legumes such as beans (*Phaseolus vulgaris*) (11 up to17 g/kg), chickpea (4.9 up to 6.1 g/kg), and soybean (10 up to 14.7 g/kg) [36,42,43,44]. Mineral contents can also be influenced by seed processing processes such as germination and cooking. Table 1 presents the nutritional content in micronutrients per 100g of *Beng-tigré* according to the technologies used [25].

With a high level of vegetable proteins, *Beng-tigré* contains, even after cooking or germination, all the essential amino acids according to Table 1 below, making it a reference legume. According to the same Table 1, *Beng-tigré* contains many more polyunsaturated fatty acids than saturated, whether the seed is germinated, cooked or raw [25]. These polyunsaturated fatty acids give an added value to *Beng-tigré* in view of their importance in the diet. Several minerals are also present in the seed of *Beng-tigré* and remain more after cooking than germination, except for sodium. Many vitamins are contained in the seed of *Beng-tigré* and some are revealed even more with germination. Indeed, alpha carotene and beta crypto xanthine are only present in the germinated seed. Ascorbic acid and vitamin K are more abundant in germinated seed than in raw and cooked seed (about four and ten times, respectively) [25]. Also, the content of bioactive compounds such as isoflavones and flavanols contained in *Beng-tigré* increases only with germination as recorded in Table 1. According to several authors, *Beng-tigré*, because of its low carbohydrate composition, is a food with a low glycaemic index, even after cooking or germination [17,25,45].

Table 1. Nutritional Composition of the Micro-nutrients per 100g of *Beng-tigré*

Nutritional elements		Unit	Raw		Germinated		Cooked	
Amino acids	Tryptophan	g	0.260^^	0.97++	0.037^^	0.95++	0.076^^	1.00++
	Threonine	g	0.782^^	3.15++	0.078^^	3.20++	0.230^^	3.20++
	Leucine	g	1.847^^	8.36++	0.175^^	8.53++	0.544^^	8.44++
	Isoleucine	g	1.008^^	4.74++	0.132^^	4.70++	0.197^^	4.40++
	Lysine	g	1.664^^	4.19++	0.166^^	4.26++	0.490^^	4.05++
	Methionine	g	0.286^^	1.92++	0.034^^	1.95++	0 .084^^	1.83++
	Cysteine	g	0.210^^	0.76++	0.017^^	0.77++	0.062^^	0.76++
	Phenylalanine	g	1.443^^	5.66++	0.117^^	5.70++	0.425^^	5.67++
	Tyrosine	g	0.714 ^^	3.27++	0.052^^	3.28++	0.210^^	3.23++
	Valine	g	1.237^^	5.20++	0.130^^	5.20++	0.364^^	5.20++
	Arginine	g	1.672^^	6.33++	0.197^^	6.35++	0.492^^	6.00++
	Histidine	g	0.695^^	2.49++	0.070^^	2.42++	0.205^^	2.54++
	Alanine	g	1.050^^	4.35++	0.099^^	4.41++	0.309^^	4.58++
	Aspartic acid	g	2.756^^	13.5++	0.479^^	13.5++	0.812^^	13.8++
	Glutamic acid	g	4.264^^	21.7++	0.161^^	21.8++	1.256^^	21.8++
	Glycine	g	0.954^^	4.26++	0.063^^	40.20++	0.281^^	4.40++
	Proline	g	1.095^^	4.23++	0.00^^	4.20++	0.323^^	4.36++
	Serine	g	1.176^^	4.95++	0.033^^	4.80++	0.346^^	4.90++
Lipids	Saturated fatty acids	g	0.348^^		0.046^^		0.116^^	
	Monounsaturated fatty acids	g	0.161^^		0.022^^		0.054^^	
	Polyunsaturated fatty acids	g	0.384^^		0.058^^		0.128^^	
	Phytosterols	mg	23^^		15^^		0^^	
Carbohydrates	Total Sugar	g	6.60^^	4.85++	4.13^^	3.10++	2.00^^	3.21++
Minerals	Calcium	mg	132^^	90++	13^^	88.5++	27^^	75.00++
	Iron	mg	6.74^^		0.91^^		1.40^^	
	Magnesium	mg	189^^	166++	21^^	56.6++	48^^	44++
	Phosphorus	mg	367^^	365++	54^^	406++	99^^	368++
	Potassium	mg	1246^^	171++	149^^		266^^	
	Sodium	mg	15	9.0++	6^^	11.00++	2^^	8.20++
	Zinc	mg	2.68^^		0.41^^		0.84^^	
	Copper	mg	0.941^^		0.164^^		0.156^^	
	Manganese	mg	1.034^^		0.188^^	1.70++	0.298^^	1.30++
	Silicon	ug	8.2^^		0.6^^		2.5^^	
Vitamins	Vitamin A	UI	114^^		21^^		24^^	
	Vitamin E	mg	0.51^^		0.10^^		0.15^^	
	Vitamin K	ug	9.0^^		33.0^^		2.7^^	
	Vitamin B6	mg	0.382^^		0.088^^		0.067^^	
	Folate	ug	625^^		61^^		159^^	
	β-carotene	ug	68^^		6^^		14^^	
	Ascorbic acid	mg	4.8^^		13.2^^		1.0^^	
	Niacin	mg	2.251^^		0.749^^		0.577^^	
	Riboflavin	mg	0.233^^		0.124^^		0.061^^	
	Pantothenic acid	mg	1.910^^		0.380^^		0.410^^	
	Choline	mg	97.9^^		14.4^^		29.4^^	
	α-carotene	ug	0^^		6^^		0^^	
	β-Crypto-Xanthine	ug	0^^		6^^		0^^	
	Thiamine	mg	0.621^^		0.084^^		0.164^^	
Isoflavones	Daidzein	mg	0.00^^		0.06^^		0.01 ^^	
	Genistein	mg	0.09^^		0.08^^		0.01^^	
	Total isoflavones	mg	0.09^^		0.10^^		0.01^^	
	Biochanin A	mg	0.00^^		0.01^^		0.00^^	
	Formononetine	mg	0.21^^		0.01^^		0.00^^	
	Coumestrol	mg	0.00^^		0.93^^		0.00^^	
Flavonols	Kaempferol	mg	0.1^^		0.3^^		0.00^^	
	Myricetin	mg	0.1^^		0.00^^		0.00^^	
	Quercetin	mg	0.1^^		0.1^^		0.00^^	

Source : ^^ [25] ; ++[11].

5. Food Products Derived from *Beng-tigré*

Beng-tigré seeds are used in the production of a variety of dishes in Burkina Faso and other parts of the world. In Asia, mature *Beng-tigré* seeds are used in the production of soup, toast, porridge, snacks, noodles and even ice cream [29,46]. The formulation and production of novel foods and beverages also use flour obtained from seeds. This is the case in Burkina Faso, where *Beng-tigré* is used in the production of couscous, pasta, lumpy food, biscuits, chips, bread, liquor and plain juice or in combination with ginger (*Zingiber officinale*) or

bissap (*Hibiscus sabdariffa*). It is also eaten alone or mixed with cereals such as corn or rice and transformed into local dishes such as *gonré* and doughnuts. The various foods derived from *Beng-tigré* are made from the whole seed of *Beng-tigré* in association with either cereals (wheat, rice, millet), or other legumes (cowpea, sesame), or non-timber forest products (monkey bread, *néré* pulp).

Legend: **A** : *Beng-tigré* seeds ; **B**: *Beng-tigré* packed in 1kg bags; **C**:*Beng-tigré* flour packed in 1kg; **D**:*Beng-tigré* based dough chips; **E**: Couscous based on *Beng-tigré*; **F**: *Beng-tigré* sweet shortbread biscuit; **G**: Salted biscuit of *Beng-tigré*; **H**: *Beng-tigré* chips; **I**: *Beng-tigré* Bread; **J**: Sesame enrichied *Beng-tigré* bread; **K**: Pancake made from *Beng-tigré*; **L**: Pasta of *Beng-tigré*; **N**: *Beng-tigré* seasoned with tomato sauce; **M**: *Beng-tigré* with rice; **O**: *Beng-tigré* couscous with rice; **P**: enrichide *Beng-tigré* juice; **Q**: *Beng-tigré* liquor

Figure 6. *Beng-tigré* dishes and beverages processed by FIBSO

Figure 6 shows pictures of these *Beng-tigré* based products. Several studies have shown that *Beng-tigré* has very interesting organoleptic and nutritional qualities and it is often used in the fortification of infant foods [23,47].

6. Therapeutic Functions of *Beng-tigré*

6.1. Bioactive Compounds of *Beng-tigré* and Their Therapeutic Interests

Bioactive compounds are molecules that have ability to act on the functions of body both directly and indirectly. Of animal or plant origin, they are classified into three groups depending on their structures: polyphenols, polysaccharides and peptides.

6.1.1. Polyphenols

Cotyledons and teguments of *Beng-tigré* have a high level of phenolic acids, flavonoids and tannins content [48,49]. [50,51] found that germination and fermentation improve significantly the content of bioactive molecules in the products. The content of phenolic acid, vitexin and isovitexin can be increased by seed germination [52,53]. According to the literature, polyphenols have antibacterial, anti-tumour, anticarcinogenic, antiviral, hypotensive, anti-inflammatory, antidiabetic and antioxidant properties [54-63]. For example, vitexin, isovitexin and other polyphenols (isovitexin-6"-O-α-l-glucoside and dulcinoside) present in *Beng-tigré are* readily found in organs such as the liver, spleen, heart, kidneys, brain and lungs to induce host benefits [64].

6.1.2. Polysaccharides

Polysaccharides have an important role in the physiological activities of human body [65]. [66] studied the structural properties of an acidic arabino-galactan (AGP-2), isolated from *Beng-tigré*, and its role in macrophage activation. AGP-2 was found to be one of the most interesting immunomodulators [66]. It is also established that alkali-soluble polysaccharides isolated from *Beng-tigré* have the ability to activate macrophages [66,67].

6.1.3. Peptides

Polymers of amino acids, linked together by peptide bonds, peptides in the body have an enzymatic, energetic and structural role. *Beng-tigré* contains proteins which, after digestion, release amino acids with very important biological activities) [68,69]. According to the same authors, these peptides are responsible for the inhibition of Angiotensin Converting Enzyme I (ACE), an inhibition that helps regulate blood pressure in consumers. [18] also reported that the *Beng-tigré* protein hydrolysate exerts a strong inhibitory activity on ACE.

6.2. *Beng-tigré* as a Prebiotic for Health

Prebiotics are non-digestible compounds that, by selectively stimulating the growth of intestinal microbiotas, have a beneficial effect on host health according to [70]. Whole grains and legumes are vectors for prebiotic compounds. They help maintain homeostasis and functions of intestinal microbiota and are often used as nutraceuticals [71,72]. However, several studies have shown that the *Beng-tigré* is rich in dietary fibres, polysaccharides, peptides and polyphenols [25,48,73]. This is what has sparked the interest of researchers on this legume for its use as a prebiotic.

6.3. Antioxidant Activity of *Beng-tigré*

Seeds, germs and teguments of *Beng-tigré* have a high level of molecules endowed with antioxidant activity. These properties have been reported in several studies: [74,75]. These same authors reported that the germination of *Beng-tigré* seeds allows an increase in the content of bioactive molecules, hence the increase in antioxidant activity. Compared to natural seeds, germinated seeds of *Beng-tigré* has a very high antioxidant potential [76]. Table 2 presents the antioxidant potential of *Beng-tigré* as reported by different authors.

Table 2. Antioxidant Potential of *Beng-tigré*

Concerned party	Activity, doses and duration	Reference and type of study
Musk bean sprouts (vitexin and isovitexin).	Antioxidant at 104g	[52]
	Antioxidants and	[77] ++
	Myocardial protection (100 µl, 6 mg and 750 mg for 168 h)	[78] ^^
	Antioxidant (250 mg, 1000 mg during 168h)	[79] ^^
Bean Seeds	Antioxidants and anti-diabetic agents	[80] ++
Methanolic extract of teguments	Antioxidant activity at 100 mg	[81] ++
Methanol extract	Anti-radicals, antioxidant and anti-diabetic 250 mg	[82] ^^
Fermented Seed	Antioxidants and lipid-lowering (200 mg, 1000 mg for 1344h)	[83] ^^

Legend: ++ experiment performed in vitro; ^^ experiment performed in vivo.

7. Role of *Beng-tigré* in the Prevention of Metabolic Diseases

Formerly used in traditional medicine by Asians, *Beng-tigré* is nowadays a world-renowned legume due to its nutritional content and therapeutic properties. [84] reported that regular consumption of *Beng-tigré* has beneficial effects on the health of consumer. Several effects have been reported, these are anti-inflammatory, anti-diabetic, anti-cancer, anti-cholesterolemia and antihypertensive [17,85,86,87,88,89]. It could therefore play an important role in preventing certain diseases.

7.1. Anti-diabetic Activities

While long-term consumption of foods with a high glycaemic index may be a trigger for the onset of diabetes,

its control requires the consumption of foods with a low glycaemic index. According to [90], diets with a low glycaemic index of up to 10% increase insulin sensitivity in the body by up to 30%. *Beng-tigré*, being a food with a low glycaemic index, would be a potential antidiabetic candidate [17,45]. Indeed, studies have shown that the consumption of *Beng-tigré* based meals induces a low glycaemic response compared to some cereals such as rice and corn [78,91,92,93]. Table 3 presents the results of in vitro biochemical assays of *Beng-tigré* and its active compounds in the control of hyperglycaemia.

7.2. Anti-hyperlipidemia and Anti-hypertension Activity

Commonly encountered metabolic diseases such as cardiovascular disease (CVD), hyperlipidaemia and obesity are linked to an increase in Total Cholesterol (TC), blood glucose, triglycerides (TG) and Low-Density Lipoproteins (LDL) in the blood, along with a considerable decrease in High Density Lipoproteins (HDL) levels [85,99]. Regular consumption of *Beng-tigré* has beneficial effects on health. It leads to a decrease in LDL, TG, TC and an increase in HDL in the consumer [84]. The protein hydrolysates of *Beng-tigré* allow a significant reduction in blood pressure [18]. According to [86,100] and [69], these *Beng-tigré* protein hydrolysates significantly inhibit ACE for blood pressure regulation.

Experimental studies have reported that the lipid metabolism of *Beng-tigré has a* modulating role. According to [101,102], cholesterol reduction can be induced by the phytosterol of *Beng-tigré* extracts. Symptoms of CVD and atherosclerosis could, however, be relieved by using hydroalcoholic extract of *Beng-tigré* seeds which helps to lower TG and LDL levels [101]. Table 4 presents the lipid-lowering properties of *Beng-tigré*.

7.3. Anticancer and Hepato-protective Activities

Despite genetic susceptibility, smoking, chronic inflammation and immunosuppression, the choice of foods consumed over a lifetime can determine the likelihood of carcinogenesis at all phases of cancer process [107]. Epidemiological studies have suggested that the consumption of *Beng-tigré* reduces the prevalence of colon, breast, and prostate cancers [108,109]. [88] reported inhibitory effects of *Beng-tigré* trypsin on the anticancer activities and proliferation of human colon cancer cells. Dietary fibre, phenolic compounds and micronutrients such as phytic acid, vitexin, isovitexin, protease inhibitors and saponins contained in *Beng-tigré* has antioxidant and anticarcinogenic properties [19,110]. A study has shown that aqueous extracts of fermented *Beng-tigré* can delay the formation of breast cancer and promote tumour reduction [111]. The liver, a central inflammatory organ involved in metabolism, storage and excretion of metabolites, can be damaged by alcohol, viruses and autoimmune diseases [112,113]. Whole or germinated *Beng-tigré* has been shown to be an effective hepato-protective agent, capable of decreasing liver enzyme activity and liver histopathology in a dose-dependent manner [114]. In addition, the aqueous extract of *Beng-tigré*, like certain beans and cereals such as rice, has shown a very interesting hepato-protective effect on acute hepatic lesions induced by acetaminophen [115].

Table 3. Biochemical Assays of Active Compounds of *Beng-tigré* for Controlling Hyperglycaemia

Active compounds	Activity and dose required	References
Flavonoids and Lignane	Anti-glucosidase activity α-glucosidase (20µl/1650 µl)	[80]
Vitexin and isovitexin	Inhibition of glycation end products (500ppm, 100µm)	[94]
Phenolic compounds	Anti α-glucosidase activity and inhibition of glycation end products (50µl/200µl; 1ml/3ml)	[93]
Aqueous extract	Anti-glucosidase activity α-glucosidase (800µl/6µl)	[95]
Aqueous extract (raw, boiled and germinated)	Anti α-glucosidase and anti-amylase activity (20µl/220µl	[96]
Ethanolic extract of teguments	Anti-glucosidase activity α-glucosidase(5mg/ml)	[97]
Ethanolic extract of whole seed, cotyledon and bark	Inhibition of aldose reductase activity (0.1ml/1ml)	[98]

Table 4. Hypolipemic Properties of *Beng-tigré*

Dose for health	Model	Biological activities	Reference
Musk bean sprouts (30%) as a dietary supplement for 46 days	Fructose supplementation in hypertensive rats	Decrease of: TG, TC, Heat Rate, Liver Cholesterol	[103]
Supplementation of *Beng-tigré* (1% and 2%) as a dietary supplement for 42 days	Cholesterol-enriched Mouse Diet	Increase of: coprosterol, total neutral sterol, deoxycholine acid Apparent decrease in cholesterol absorption	[104]
Sprout juice (0.67 and 1.34mg/200g) for 28 days	Induction in the diet of obese rats	Decrease of: TC, TG, LDL, HDL increase	[105]
Fermented and unfermented aqueous extract (1000mg and 200mg/ Kg) for 14 days	Cholesterol-enriched Mouse Diet	Decrease of: TC, TG, LDL, ALT, ALP, MDA, FRAP, NO, body weight and liver triglycerides Increase in HDL, SOD	[106]

Legend: High density lipoproteins (HDL); Malondialdehyde (MDA); Superoxide dismutase (SOD); Ferric reducing antioxidant power (FRAP); Total Cholesterol (TC); Triglyceride (TG); Low-density lipoproteins (LDL); Alanine aminotransferase (ALT); Alkaline Phosphatase (ALP); Nitric Oxide (NO).

7.4. Anti-inflammatory and Immunomodulating Activity

Various inflammatory diseases are currently treated by inhibiting the overproduction of inflammatory mediators, pro-inflammatory cytokines in particular. For example, several studies have reported the anti-inflammatory effect of *Beng-tigré* against sepsis and ear oedema by inhibiting pro-inflammatory factors [87,116,117,118] and many other authors have reported that vitexin and isovitexin extracted from *Beng-tigré* reduce macrophage activity by inhibiting pro-inflammatory gene expression without cytotoxicity and induce a decrease in inflammatory cytokines [89,118,119]. Similarly, [120] or [121] reported that *Beng-tigré* has a very interesting immunomodulatory activity.

8. Conclusion

A plant resilient to the effects of climate change, *Beng-tigré* grows on many soil types in warm regions. A reference legume because of its nutrient composition, its seeds are used in the preparation of a variety of dishes in Burkina Faso and other regions of the world. In combination with other cereals or non-timber forest products, several dishes based on *Beng-tigré* seeds are consumed and contribute to the reduction of micronutrient malnutrition, which affects more than half of the world's population. *Beng-tigré*, given its composition of nutrients and bioactive compounds, especially polyphenols, polysaccharides and polypeptides, is a functional food that can be very useful in preventive medicine. Rich in antioxidants, *Beng-tigré* has shown beneficial effects on health through in *vitro* and in *vivo* studies. Liver diseases (cirrhosis, steatosis, hepatitis) or metabolic diseases (type II diabetes, hypertension, cancer) or even immune diseases (multiple sclerosis, lupus, type I diabetes) are relieved by the consumption of *Beng-tigré*, according to several studies. Consumed extensively in Asian countries, *Beng-tigré* could serve as a staple food for some countries in Africa in the control of chronic degenerative diseases that are becoming increasingly worrisome. While several in vivo studies have been conducted on laboratory animals, it will be even more valuable to do randomised dietary follow-up with *Beng-tiré* on groups of people to study its metabolism through biochemical analysis. Also, more and more evidence has revealed reciprocal interactions between gut microbiota and functional food components and their consequences on human health. The effect of the microbiota involved in *Beng-tigré* in therapeutic interventions remains to be elucidated. In addition, several varieties of *Beng-tigré* are grown in India and Africa. Our current knowledge does not allow us to decide on the best varieties for the prevention of chronic diseases. It will therefore be necessary to conduct further studies on the most widely consumed varieties in order to draw conclusions. In addition, *Beng-tigré* is generally subjected to culinary treatments and parameters such as germination and soaking time of the seeds before processing or cooking could impact the composition of nutrients and bioactive molecules. Therefore, it is necessary to assess the impact of the processes at the local level by phytochemical screening of processed *Beng-tigré* seeds in order to deduce their biological activities. It would be interesting to also deepen the studies to better identify the synergistic effects of the multiple components of *Beng-tigré* and to ensure therapeutic convenience.

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Conflict of Interest

The authors declare that they have no competing interests.

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