

Review Article

Nutritional composition, functional properties and food applications of Millet grains

Abstract

Millet is an important nutritious ancient minor cereal food crop. This work reviews the composition, functional properties and food application of millet grains. The review shows that this cereal grains is a rich source of carbohydrate and starch, with little of proteins, fat, vitamins and other nutrients. The functional properties of the cereal grains (Millet) was also evaluated and the findings gotten from various authors shows that the grains has a good functional properties in terms of their bulk density, oil absorption capacity, water absorption capacity, least gelatinization temperature and host of others. The pasting properties were also researched on and various authors attested to the potentiality of the grains in terms of the pasting properties. The food applications of the grains was not left out since the basic essence of this review is to see to the betterment of the livelihood of human, as such the various foods that can be produced from these grains were also looked into foods like millet ball “Fura”, tuwo, gruel, alcoholic beverages (like pito, burukutu) and non-alcoholic beverages (like “kunu zaki”) where all examined and conclusively the grains were rich sources of meals.

Keywords: Millet, Flour, Kunu, cereals, grains.

1.0 Introduction

22 The term millet is derived from the French word “*mille*” which means thousand, with a handful
23 of millet containing up to 1000 grains [1]. Millet belongs to the group of small-seeded species of
24 cereal crops or grains which are annual plants [2]. The grain belongs to the family *Poaceae*
25 which originated in Ethiopia and the sub-family *Chloridodeae* [3]. Different cultivars of millet
26 grains exist: brown, light brown and white [4, 5], with grain colour used as the distinct means of
27 cultivar differentiation. The white cultivars have been developed mainly for the baking industry,
28 the brown and light brown types used for porridge while the brown cultivar is utilized for
29 brewing traditional opaque beer in Southern Africa [6].

30 The grain millet is a semi-arid region crop cultivated in dry areas with limited rainfall and can
31 adapt to various agro-climatic conditions [7]. Period of cultivation of the grain ranges between
32 February and August with harvest period set in June or January. Millet grains are cultivated in
33 Nepal [8], Sri Lanka, Bhutan and the Himalayan regions of India. The grain is also cultivated in
34 Taiwan, China, Japan (to a limited extent), as well as in South Carolina in the United States.
35 About 55-60% of globally produced millet is cultivated in Africa [9] mainly in Ethiopia, Kenya,
36 Nigeria, Malawi, Tanzania, Uganda, Zambia and Zimbabwe. The grain is widely cultivated in
37 Africa using different names. The total annual production of all millets worldwide is
38 approximately 4.5-5 million tons [10], with India alone producing about 2.5 million tons and
39 some countries in Africa accounting for about 2 million tons of the grains. India is thus reported
40 to be the largest producer of millet [2], contributing a total of 60% of the global production [6].

41 Millet grains are gluten-free, non-acid-forming [9], easy to digest with low glycemic index [11].
42 Its low glycemic index food property is reported to be a good choice for people with celiac
43 disease (disease caused by gluten-containing cereal protein ingestion) and diabetes as
44 consumption of the grain assist in the regulation of blood glucose level [12]. The grains consist

45 of dietary fiber, carbohydrates, iron and calcium in high concentration when compared to other
46 cereal grains. Millet grains also contain high amount of magnesium and phosphorus [13].
47 Krishnan *et al.* [14] reported that millet grains contain polyphenols and phytates which are
48 known to influence the bioavailability of minerals. In addition to their nutritive value, several
49 potential health benefits such as preventing cancer and cardiovascular diseases, reducing tumor
50 incidence, lowering blood pressure, risk of heart disease, cholesterol and rate of fat absorption,
51 delaying gastric emptying, and supplying gastrointestinal bulk have been reported for millet [13,
52 15, 16].

53 Millets are small-seeded with different varieties such as pearl millet (*Pennisetum glaucum*),
54 finger millet (*Eleusine coracana*), kodo millet (*Paspalum setaceum*), proso millet (*Penicum*
55 *miliaceum*), foxtail millet (*Setaria italic*), little millet (*Panicum sumatrense*), and barnyard millet
56 (*Echinochloa utilis*). They are known as coarse cereals beside maize (*Zea mays*), sorghum
57 (*Sorghum bicolor*), oats (*Avena sativa*), and barley (*Hordeum vulgare*) [17]. Millet is known as
58 *ragi* and *mandia* in the Bastar region of Chhattisgarh and offers both nutritional and livelihood
59 security for human beings and also feed security for diverse livestock populations in dry land
60 regions of rural India [18].

61 Millets are not placed as a single important commodity in the North American and European
62 food basket at the present time, but their importance as an ingredient in multigrain and gluten-
63 free cereal products has been highlighted. However, in many African and Asian areas, millets
64 serve as a major food component and various traditional foods and beverages, such as bread
65 (fermented or unfermented), porridges, and snack foods are made of millet, specifically among
66 the non-affluent segments in their respective societies [19]. Millet grains, before consumption
67 and for preparing of food, are usually processed by commonly used traditional processing

68 techniques include decorticating, malting, fermentation, roasting, flaking, and grinding to
69 improve their edible, nutritional, and sensory properties. Processing of millet grains comprises
70 both the traditional and modern methods. The modern methods of processing can be employed in
71 the manufacture of value-added products such as soaked, cooked, malted, fermented, popped or
72 puffed, extruded and multi-grain flour. Traditional methods of millet processing also include a
73 method of spreading and drying the grains in the sun for a period of one week. Upon drying, the
74 grains are stored in a bag and later used for the processing and manufacture of different food
75 products [20]. Dried millet grains can be stored for more than 5-10 years, but a major hurdle is
76 that the grains are very tiny and not easy to handle. The grains are resistant to diseases and
77 insects but are easily invaded by fungal disease [21]. Despite its usefulness and health beneficial
78 properties, there is little research and innovation on millet grains/flours as compared to
79 conventional cereal grains such as maize, sorghum, rice and wheat.

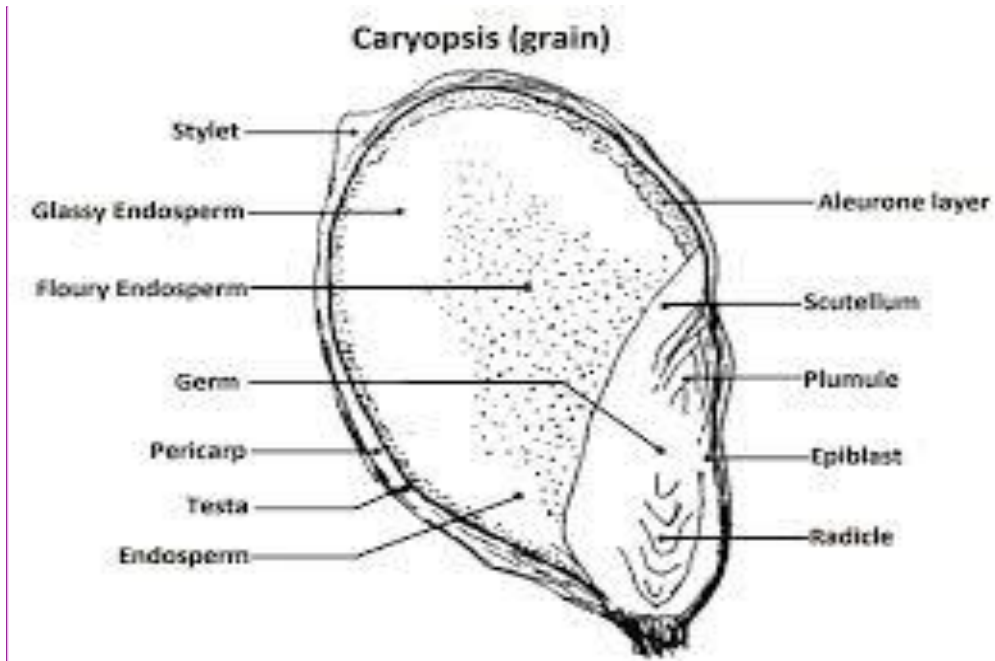
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86 Fig. 1: Longitudinal section of the Millet grain (Adopted from USDA. 2005).

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87 **2.0 Nutritional Composition of Millet**

88 Nutritional quality of food is a key element in maintaining human overall physical well-being
 89 because nutritional well-being is a sustainable force for health and development and
 90 maximization of human genetic potential. Therefore, for solving the problem of deep-rooted food
 91 insecurity and malnutrition, dietary quality should be taken into consideration [22].

92 In addition to the cultivating advantages of millet, they were found to have high nutritive value
 93 and comparable to that of major cereals such as wheat and rice [23]. Millet proteins are good
 94 sources of essential amino acids except lysine and threonine but are relatively high in
 95 methionine. Millets are also rich sources of phytochemicals and micronutrients [24, 25]. For
 96 example, pearl millet was found significantly rich in resistant starch, soluble and insoluble

97 dietary fibers, minerals, and antioxidants [26]. It contains about 92.5% dry matter, 2.1% ash,
98 2.8% crude fiber, 7.8% crude fat, 13.6% crude protein, and 63.2% starch [27]. Also, foxtail
99 millet protein characterization showed that its protein concentrate is a potential functional food
100 ingredient and the essential amino acid pattern suggests possible use as a supplementary protein
101 source to most cereals because it is rich in lysine [28]. Finger millet *also* is known to have
102 several potential health benefits and some of the health benefits are attributed to its polyphenol
103 contents [29]. It has a carbohydrate content of 81.5%, protein 9.8%, crude fiber 4.3%, and
104 mineral 2.7% that is comparable to other cereals and millets [30]. Its crude fiber and mineral
105 contents are markedly higher than those of wheat (1.2% fiber, 1.5% minerals) and rice (0.2%
106 fiber, 0.6% minerals); its protein is relatively better balanced; it contains more lysine, threonine,
107 and valine than other millets [31]. In addition, black finger millet contains 8.71 mg/g dry weight
108 fatty acid and 8.47 g/g dry weight protein [32]. Kodo millet and little millet were also reported to
109 have 37% to 38% of dietary fiber, which is the highest among the cereals; and the fat has higher
110 polyunsaturated fatty acids [33]. The protein content of proso millet (11.6% of dry matter) was
111 found to be comparable with that of wheat with significant higher content of leucine, isoleucine,
112 and methionine [34]. Thus, the presence of all the required nutrients in millets makes them
113 suitable for large-scale utilization in the manufacture of food products such as baby foods, snack
114 foods, and dietary food and, increasingly, more millet products have entered into the daily lives
115 of people, including millet porridge, millet wine, and millet nutrition powder from both grain and
116 flour form [35, 36].

117 **3.0 Functional Properties of Millet**

118 Cereal grains contain 60 to 70% starch and are excellent energy rich food for human. Doctors
119 recommended cereals as the first food to be added to infant diets and a healthy diet for adults

120 should have most of its calories in the form of complex carbohydrates such as cereals grain
121 starch. Cereals and millets form the staple food of diets in about 75% of the countries of the
122 world [37].

123 Cereals are an excellent source of vitamin and minerals including fat soluble vitamin E, which is
124 an essential antioxidant. The cereal grains are an easy protein source as required by
125 Recommended Daily Allowance (RDA) but unfortunately they lack the essential amino acid
126 lysine and therefore they must not be used as the sole source of dietary protein [38]. Cereal
127 grains contain about 58 to 72% carbohydrates, 8 to 13% protein, 2 to 5% fat, and 2 to 11%
128 indigestible fibre. They also contain 300 to 350 kcal/100 g of the grain. Carbohydrates are
129 present in the form of digestible starches and sugars. The operations of milling generally remove
130 much of the indigestible fibre and fat from the grains when they are to be consumed for human
131 food.

132 Functional properties are the fundamental physico-chemical properties that reflect the complex
133 interaction between the composition, structure, molecular conformation and physico-chemical
134 properties of food components together with the nature of environment in which these are
135 associated and measured [39, 40]. Functional characteristics are required to evaluate and possibly
136 help to predict how new proteins, fat, fibre and carbohydrates may behave in specific systems as
137 well as demonstrate whether or not such protein can be used to stimulate or replace conventional
138 protein [39, 40].

139 The food property is characterized of the structure, quality, nutritional value and /or acceptability
140 of a food product. A functional property of food is determined by its physical, chemical, and/or
141 organoleptic properties. Example of such functional properties may include solubility,
142 absorption, and water retention, frothing ability, elasticity and absorptive capacity for fat and

143 foreign particulars, pasting properties, emulsification, hydration (water binding), viscosity,
144 foaming, solubility, gelation, cohesion and adhesion.

145 **3.1 Water Absorption Capacity (WAC)**

146 Water absorption capacity is the amount of water taken up by flour to achieve the desired
147 consistency and create a quality end-product. Flour with high water absorption may have more
148 hydrophilic constituents such as polysaccharides. Protein has both hydrophilic and hydrophobic
149 nature and therefore they can interact with water in foods. Increase in the WAC has always been
150 associated with increase in the amylose leaching and solubility, and loss of starch crystalline
151 structure. Thilagavathi *et al.* [41], compared WAC of various types of millet with wheat and
152 soybeans flour and found out that it ranged from 74.08 to 76.83 ml/100g, 74.08 to 78.83 ml/100g
153 and (58.17- 60.02 ml/100g) for millet, wheat and soybean flour respectively. The observed
154 variation in different flours may be due to different protein concentration, their degree of
155 interaction with water and conformational characteristics [42].

156 **3.2 Oil Absorption Capacity (OAC)**

157 OAC has been attributed to the physical entrapment of oil; this is important since oil acts as
158 flavor retainer and increases the consumers' taste of food [43]. OAC of millet flour has been a
159 wide research that has been conducted by various researchers at varying conditions and different
160 results obtained. The oil absorption capacity according to Amir *et al.* [44], on finger millet flour
161 was found to be 1.93g/g and that of pearl millet flour is 1.60g/g. There is an advantage for best
162 organoleptic characteristics of meal that high water and oil absorption capacity of the flour can
163 positively influence the flavor, moisture and fat content in food [45].

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166 3.3 Bulk Density

167 Bulk density is a measure of heaviness of flour and is generally affected by the particle size and
168 the density of the flour. It is very important in determining the packaging requirement, material
169 handling and application in wet processing in the food industry. According to Amir *et al.* [44],
170 the bulk density of pearl millet and finger millet flours ranged from 0.67g/ml to 0.54g/ml. The
171 differences in the values of bulk density between these flours are likely due to varietal
172 differences. Krishnan *et al.* [46] found a bulk density of 0.5g/ml, 0.50g/ml and 0.6g/ml in native,
173 malted and hydrothermally treated finger millet seed coat.

174 3.4 Foaming Capacity and Stability

175 The Forming capacity (FC) and foaming stability (FS) are determined by a loss of liquid
176 resulting from destabilization that is measured as a volume decrease. Foaming formation is
177 governed by three factors: transportation, penetration, and reorganization of the molecule at the
178 air–water interface. Therefore, for good foaming, the protein should be capable of migrating at
179 the air–water interface, unfolding and rearranging at the interface [47].

180 Yagoub and Abdalla, [48] presented results of FC which varied from 116.55% to 151.58%. They
181 were in agreement with those of cowpea and millet flour as reported by Akubor [49] and
182 Jayathilake *et al.* [50] respectively. An increase in FC might be initiated by a decrease in surface
183 tension of the air and water interface, which consequently caused absorption of soluble protein
184 molecules for hydrophobic interactions. The FC of a food materials depended on the surface
185 active properties of its protein [51].

186 3.5 Gelatinization Temperature

187 Gelatinization temperature of all the flour samples investigated by Iwe *et al.* [52], ranged from
188 29.00 to 74.00°C and it fell within the range (<75°C) reported by ARSO [53]. There is a

189 significant variation between the flour varieties in their gelatinization temperatures.
190 Gelatinization temperature is the temperature at which starch molecules in a food substance lose
191 their structure and leach out from the granules as swollen amylose and it affects the time required
192 for the cooking of food substances [54]. According to Chandra and Samsher, [55], a flour which
193 has a higher starch content takes lower temperature for gelatinization and those with lower starch
194 content takes higher temperature to gelatinize.

195 **3.7 Pasting Properties**

196 Pasting properties are important in predicting the behavior of flours during and after cooking.
197 The difference in Peak viscosity observed in the samples is an indication of various degrees of
198 starch gelatinization and difference in amylose content of the blends. Sanni *et al.* [56] noted that
199 high peak viscosity is closely associated with the high starch damage which in turn enhances
200 viscosity.

201 Bhupender *et al.* [57] did a research on the pasting properties of starches from different pearl
202 millet cultivars measured using RVA. Starches from different cultivars displayed a significant
203 variation in all their pasting parameters. The starch suspensions showed gradual increase in
204 viscosity with increase in temperature. The increase in viscosity with temperature may be
205 attributed to the removal of water from the exuded amylose by the granules as they swell. Peak
206 Viscosity is an indicator of water binding capacity and ease with which the starch granules are
207 disintegrated and often correlated with final product quality [58]. Peak viscosity (PV) of different
208 starch samples was observed to be in the range from 1665 to 1998 cP,. Breakdown viscosity
209 (BV) of starch from different pearl millet cultivars differed ranged from 414 to 769 cP. The
210 breakdown is caused by disintegration of gelatinized starch granules structure during continued
211 stirring and heating, thus, indicating the shear thinning property of starch [59]. A low breakdown

212 value suggests the stability of starches under hot conditions. Amylose content is believed to have
213 a marked influence on the breakdown viscosity (measure of susceptibility of cooked starch
214 granule to disintegration) and the setback viscosity (measure of recrystallization of gelatinized
215 starch during cooling) [60]. Lower level of amylose to reinforce the molecular network within
216 the granules resulted in greater breakdown viscosity. High amylose content has also been
217 suggested as the major factor contributing to the non-existence of a peak, a high stability during
218 heating, and a high setback during cooling [61, 62]. Setback viscosity of pearl millet starches
219 ranged from 627 to 1064 cP. Final viscosity indicates the ability of the starch to form a viscous
220 paste. Final viscosity of pearl millet starches ranged from 1931 to 2476 cP. A higher final
221 viscosity relates to the high resistance to shear. Increase in final viscosity might be due to the
222 aggregation of the amylose molecules. Pasting temperature of starch suspensions ranged from
223 88.1 to 90.2°C. Stability ratio explains the resistance of a starch paste to viscosity breakdown as
224 shear is applied.

225 **4.0 Food Application of Millet**

226 **4.1 Tuwo Production**

227 Tuwo is a local delicacy of the Northern part of Nigeria; it is made from millet, maize or
228 sorghum as the case may be and the choice of the producer. Tuwo is a solid food which is made
229 in forms of balls or swallows; it is made from the flour produced from any of the above
230 mentioned grains [63]. According to Odusola *et al.* [64], tuwo is produced by getting millet, the
231 grain is then sorted, dehulled, winnowed and mill into smooth flour and then sieve appropriately,
232 water will be heated in the pot to boil, little portion of the flour is used to make a slurry in a cold
233 water and its then transferred in to the boiling water and is allowed to boil together properly.
234 After which the sieved flour of the millet is pour gradually into the pot containing the boiled

235 water and the boiled slurry and stir until a desired thickness is obtained, the food is allowed to
236 heat for additional ten to fifteen minutes and it's then stirred and it's ready to be served with any
237 desired soup.

238 **4.2 Millet Ball Production “Fura”**

239 Fura is a staple food for the Fulanis and Hausas. The single most important cereal grain for fura
240 production is millet or its twin grain sorghum [65]. In tropical Africa, millet grains are milled
241 and used to produce thick porridges which are known by various names in different parts of the
242 continent. In west Africa particularly in Nigeria, Ghana and Burkina Faso, one such thick
243 porridge is called ‘fura’ - a semi- solid dumpling cereal meal [66]. Fura is produced mainly from
244 moist millet flour, blended with spices, compressed into balls and boiled for 30 minutes. While
245 still hot, the cooked dough is worked in the mortar with the pestle (with addition of hot water)
246 until a smooth, slightly elastic, cohesive lump (fura) is formed. The fura dough is rolled into 25–
247 30 g balls by hand and dusted with flour. The fura is made into porridge by crumbling the fura
248 balls into fermented whole milk (kindrimo) or 24 fermented skim milk (nono) [66]. Sugar may
249 be added to taste, the mixture is called ‘fura da nono’ in Nigeria. It is a popular mid-day meal.
250 Fura is produced at home both for family and commercial consumption. The producers of fura
251 still use the modern method to dehull the grain and to reduce the dehulled grain into flour on like
252 the formal traditional methods of mortar and pestle thing. Fura is typically distributed with
253 minimum packaging. Processors and retailers of fura are primarily concerned with reducing
254 waste and having a container for their food. Fura has a limited shelf-life of one day at ambient
255 temperature [66]. Usually, a day after production, fura shows visible mold growth on the surface.
256 The short shelf-life has always been a major deterrent to large-scale production. Thus, improving

257 the processing, packaging and storage life of fura are of interest before food manufacturers can
258 think of large scale production.

259 **4.3 Gruel Production**

260 Millet has been used for gruel production or as breakfast meals which are in turn produced into
261 pap, “ogi”, “akamu” etc and are taken with any other desired snacks for adequate nourishment
262 and some the gruels are been enriched with other food products like soybeans, ginger and host of
263 other [67].

264 In the production of the gruels, the raw millet is graded, washed and soaked for 72 hours and the
265 water decanted, some producers change the water daily that is after 24 hours while others leave it
266 for that period of 72 hours fermentation. The fermented grains are then washed and wet milled in
267 a clean grinding machine. The grain slurry is then filtered with muslin cloths and the filtrate is
268 allowed to sediment and the water decanted. Then the slurry or gruel can be cooked and made
269 into pap, ogi, akamu, kwokwo and host of others dependant on the choice of the producers [64].

270 **4.4 Local Alcoholic Beverage Production**

271 In many times past barley has been the sole cereal grains that are used in the production of
272 alcoholic beverages in Western part of Africa and Nigeria inclusive, this practice has left us in
273 the dependant stage of life, adding no dividend to the economy of the country; rather it takes
274 from it to expand and enrich others and growing us in the rank of a dependent Nation. Recent
275 research works has strive to break that barrier of over dependency by introducing other means of
276 using home grown grains in the production or manufacture of some of this alcoholic beers and
277 beverages, of which millet is part of this innovations. Alcoholic beverages are divided into three
278 (3) general classes: beers, wines and spirits. Alcoholic beverages that have lower alcohol content
279 (beer and wine) are produced by fermentation of sugar- or starch containing plant materials.

280 Beverages of higher alcohol content (spirits) are produced by fermentation followed by
281 distillation. The major local alcoholic beverages produced in Nigeria are Burukutu, palmwine,
282 pito, and Ogogoro. Burukutu beer is a traditional cereal-based fermented beverage. Cereals are
283 important in many parts of the world as food sources, and starches from them differ in
284 physicochemical properties and molecular structures [68]. Millet is an important cereal crops
285 grown in Nigeria with starch as its main chemical component. The basic characteristics of
286 Burukutu include a sour taste due to the presence of lactic acid, a pH of 3.3 to 3.5 and an opaque
287 colour because of suspended solids and yeast. It contains vitamins, iron, manganese, magnesium,
288 potassium and calcium and also contains about 26.7g of starch and 5.9g of protein per liter [69].
289 The local beverage is known as Techoukoutou in Benin or Togo, Dolo in Burkina-Faso, Pito in
290 Ghana, Burukutu or Otika in Nigeria, Bilibili in Tchad, Mtama in Tanzania, Kigage in Rwanda
291 [70, 71]. The manufacturing processes are very variable and dependent on the geographical
292 location. Generally the production process of cereals involves, malting, steeping, germination,
293 milling, mashing, boiling, fermentation and maturation.

294 **4.5 Local Non-Alcoholic Beverage Production**

295 Millet drink (Kunu or Kunun-zaki) is a non-alcoholic, non-carbonated and refreshing cereal
296 beverage popular in Northern Nigeria and is becoming widely consumed in the South [72]. It
297 serves as breakfast drink, appetizer, weaning food and is also medicinal [73]. Kunu, is a
298 nutritious non-alcoholic drink that is produced from various cereal grains such as millet,
299 sorghum, maize and rice. Kunu is a drink that has found great appeal in the northern part of
300 Nigeria, its consumption is spread over every class of personality and it is consumed either as a
301 food supplement or thirst quencher. Kunu is cheaply available and serve as an alternative to
302 carbonated drinks products which have little or no nutritional benefits to its consumers. Kunu is

303 one of the complex mixtures which contain macromolecules such as protein, carbohydrates and
304 lipids [74]. The major important cereals which are used in the preparation of kunu are millet,
305 maize, guinea corn and rice. During the preparation of kunu, the ingredients needed are ginger
306 (*Zingiber officinals*), alligator pepper (*Afromonium melegueta*), red pepper (*Capsicum species*),
307 black pepper (*Piper guineense*) and kakandoru or eru. All these ingredients perform one function
308 or the other in the course of the preparation. The most abundant constituents of kunu is water and
309 it acts as the medium in which all other constituents are dissolved and contain only traces amount
310 of in-organic substances. The high nutritive value of kunu is attributed to the presence of protein,
311 carbohydrates and particularly, vitamin B [75]. Kunu is widely accepted as food drink in some
312 urban centres especially in the Hausa land. The quality and quantity of the products depend
313 largely on the quality of the ingredients and handling technique in the course of production by
314 the producer. The product could be obtained quantitatively after 2 days and it could be stored for
315 another 3 days when refrigerated [75]. It has however been reported that, if kunu is kept
316 overnight in hot season without being refrigerated, its quality begins to deteriorate and this may
317 lead to the spoilage which when consume could constitute danger to health [76]. Spoilage of this
318 product from observation occurs from improper handling, constant fermentation of the
319 ingredients especially the carbohydrates and enzymatic action on the substrates [75]. Hence there
320 is need for proper formulation and carbonation of the product. Carbonated drinks are desired and
321 preferred because of its sharp, unique and refreshing taste. Carbonated drinks are non-alcoholic
322 beverages that consist of CO₂, water, flavoring and some other types of sweet syrup [77]. The
323 CO₂ when introduced increases the acidity level of the drink, thereby keeping some micro-
324 organisms from growing. Thrive of microbes in a drink is what usually reduces the shelf-life of
325 the product [78]. Carbonated millet beverages (kunu) are expected to make a lot of difference

326 when compared to other available carbonated drinks because of its nutritive values among many
327 other properties which include:

- 328 i. Its ability to aid digestion and absorption of components into the body system.
- 329 ii. Boosting the immune system of the body against microbial attack.

330 Currently in Nigeria, carbonated drinks are very expensive to buy. A bottle of 50Cl costs an
331 average price of N100.00 and these have little or no nutritive value because they contained high
332 concentration of sugar and artificial concentrates. Kunu however seem to be highly nutritious
333 with relatively low cost of production and consumption. It is being prepared from our local
334 cereals which are very common and are part of our staple food substances. The problem facing
335 the satisfaction derived from kunu comes from its fast deterioration due to microbial activities
336 causing its spoilage.

337 To produce kunu, millet grain will be cleaned and steeped in twice its volume of water for 24 h.
338 Thereafter the steeped grains will be washed and spices added. The spices added will include
339 ginger, red pepper, cloves and black pepper. The steeped millet grains and spices will then be
340 wet milled in a grinding machine and sieved to remove the shafts after which the supernatant will
341 be decanted from the slurry. The slurry will be divided into two equal halves with one half added
342 to boiling water while stirring for 5 minutes, cooled to a temperature of 35°C and subsequently
343 added to the remaining half slurry. Adequate amount of water will be added to the mixture,
344 stirred and left to settle. After which, the mixture will be sieved using a muslin cloth and the
345 filtrate sweetened with granulated sugar and mixed properly to obtain the freshly processed
346 millet beverage. The product will be bottled in plastic bottles.

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349 **5.0 Conclusion**

350 In this study the composition, functional properties and food application of millet was
351 extensively examined. The review work showed high nutritional composition of this cereal
352 grains (millet). The behavioral pattern was also discussed when used industrially which portrays
353 their functional capabilities. The review showed that the product processes wide food
354 applications as also serve as good functional abilities that could help to promote human health.
355 However, research needs to focus on improving its shelf-life for industrial production.

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