

1 Original Research Article

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2 **Baking qualities of Bulgarian sorghum genotypes (*Sorghum bicolor* L.**
3 **Moench)**

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26 **ABSTRACT**

27 This study is part of an extensive scientific program in Bulgaria focused on using sorghum as an
28 ingredient in low-gluten flours for bread production. The baking qualities of new Bulgarian
29 sorghum varieties and lines were evaluated. A remix method was used in laboratory conditions to
30 bake bread from pure sorghum flour (100%) and composite blends containing 30%, 50%, and 70%
31 sorghum. Pure flour from Bulgarian common wheat variety, used in the hybrid flours, served as the
32 control. Quantitative and qualitative assessments of the baked bread were carried out, including
33 volume, weight, diameter, height, shape stability coefficient, crust surface and color, and crumb
34 quality. When considering the rheological properties, sorghum flour produced sticky dough
35 unsuitable for machine processing. The resulting bread had very low shape stability, a moist, non-
36 elastic texture, and poor crumb porosity. The crust of the bread from the sorghum varieties and
37 lines produced bread with a heavily cracked crust and dark color. Sensory analysis indicated that
38 sorghum bread had a specific smell, acidity, and astringency, in contrast to the pleasant aroma and
39 taste of wheat bread. The best results were obtained when baking bread from composite flour
40 containing 30% sorghum and 70% wheat. As the proportion of sorghum increased, the quality of
41 the baked bread deteriorated, and the varietal characteristics became more pronounced. Based on
42 the experimental results, conclusions were drawn about expanding the potential for incorporating
43 sorghum products into the food industry for producing healthy and dietary foods.

44 **Keywords:** baking qualities, dough, flour, sorghum.

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46

47 **INTRODUCTION**

48 Sorghum (*Sorghum bicolor* L. Moench) is one of the most widespread cultivated crops and ranks
49 fifth in global grain production, after wheat, rice, corn, and barley (Chanapamokkhot et al., 2007;
50 Trappey et al., 2014; Wang et al., 2016; Stoicea et al., 2025). It belongs to the Poaceae family and
51 is characterized by significant genetic diversity of germplasm (Akin et al., 2022) as well as high
52 drought resistance and low susceptibility to diseases and pests compared to other cereals (Singh et
53 al., 2014; Rajani et al., 2018; Little, 2019). These qualities have transformed sorghum from a "poor
54 agriculture" crop into a promising alternative for grain production under modern climate change
55 conditions, marked by prolonged droughts, heat stress, depletion of natural resources, and
56 environmental pollution (Slanev et al., 2024).

57 The biochemical composition of sorghum is approximately similar to that of other cereals.
58 In terms of protein content, it is comparable to corn and approaches wheat. Sorghum grains contain
59 73% of the fats found in corn and exceed those in wheat by 32%. There is a demonstrated similarity
60 between sorghum and other cereals in terms of micro- and macroelement content, essential amino
61 acids, and vitamins (Stefoska-Needham, 2024). Sorghum is rich in bioactive compounds (phenolic
62 compounds) and tannins, which have antioxidant, anti-inflammatory, and antitumor effects, lower
63 cholesterol levels, and are beneficial against obesity and diabetes (Anglani, 1998). Due to the
64 absence of gluten, sorghum is increasingly used in gluten-free food products suitable for people
65 with gluten intolerance celiac disease (gluten enteropathy). Harmful components such as phytic
66 acid and trypsin inhibitors, which have adverse effects on the human body, are eliminated through
67 various technological processing methods (sprouting, fermentation, soaking, etc.), making

68 sorghum grains and their derivatives suitable for use as food supplements (Taylor et al., 2006;
69 Duodu et al., 2019).

70 Sorghum is cultivated for various purposes. Due to its nutritional qualities similar to corn,
71 it is included in different feed mixtures for livestock farming (Slanev et al., 2012; Enchev et al.,
72 2016). Varieties richer in plant fibers are used in industries for biometanization, biomaterials, and
73 biofuels (Hernandez et al., 2019). In South Africa, China, and the USA, sorghum is used to produce
74 distilled beverages and malt for beer. It is one of the main protein sources for millions of people
75 living in semi-arid tropics because it is cheaper than other cereals and reduces food costs (Suresh
76 et al., 1999; Hugo et al., 2000; Hugo et al., 2003).

77 In the modern world, increasing attention is being paid to the quality of food products, as
78 proper nutrition is a key factor for maintaining human health and prolonging life. This explains the
79 growing interest in producing so-called functional foods in the modern baking industry, where
80 gluten-free sorghum flour is increasingly used for various types of bread (Pontieri and Guidice,
81 2016; Aguiar et al., 2026). According to Temnikova et al. (2020) baked bread containing sorghum
82 can be classified as functional because a portion of it contains more than 15% of the recommended
83 daily intake of magnesium, manganese, and silicon. The absence of the structural protein gluten in
84 sorghum flour, which is necessary for forming dough with good viscoelastic properties (Hoseney,
85 1994), is overcome by combining it with flours from other cereals. Several studies and successful
86 tests have shown that composite flours containing 30% to 50% sorghum can produce bread and
87 other baked goods with very good quality and taste characteristics, meeting the standards for safe
88 and healthy foods (Hugo et al., 2003; Yetneberk et al., 2004; Taylor et al., 2011; Pontieri et al.,

89 2016). In Bulgaria, sorghum is primarily used as a feed component, but with the growing interest
90 in healthy and dietary foods, this crop is increasingly entering the food industry.

91 In this regard, the main objective of this study is to investigate and assess the baking
92 qualities of Bulgarian sorghum varieties and lines and the possibilities of incorporating them into
93 hybrid flours with high-quality winter bread wheat in various quantitative ratios. By evaluating the
94 rheological properties of the dough and the quality of the baked bread, the effect of added sorghum
95 flour will be determined, and the most suitable genotypes for baking production will be identified.

96

97 **MATERIAL AND METHODS**

98 **Sample selection**

99 The study evaluated flours from two sorghum varieties and four lines: Maxibel, Maxired, MBA-5,
100 MBA-11, MR-12, and MR-24. These samples were obtained from the Agricultural Institute -
101 Shumen (Blvd. "Simeon the Great" 3, Bulgaria), because they were adapted to Bulgaria's climatic
102 conditions.

103

104 **Chemical composition of the sorghum flour**

105 The studied samples varied in grain color, which determines the flour color and chemical
106 composition (Table 1).

107 The following methods were used to determine the chemical composition: crude protein -
108 Kjeldahl method (Nx6,25); crude fats content - Soxhlet extraction apparatus; crude fibers - Weende
109 method; mineral substances-spectrophotometric method and calcium content - oxalate method.

110

111 **Composite mixtures used for baking**

112 The analysis of baking qualities was conducted in the laboratory for the technological qualities of
113 cereal crops at the Dobrudzha Agricultural Institute – General Toshevo (Blvd. “25 September” 80,
114 Dobrich, Bulgaria).

115 A test baking method was applied using 100% pure sorghum flour and hybrid flours
116 containing 30%, 50%, and 70% sorghum from two sorghum varieties and four lines: Maxibel,
117 Maxired, MBA-5, MBA-11, MR-12, and MR-24. As a control, the study used 100% pure flour
118 from the winter bread wheat variety Pchelina (Bulgaria), which was also part of the composite
119 mixtures.

120 To characterize the baking qualities of the sorghum varieties and lines, experimental flour
121 was prepared by milling with a Buhler MLU 202 roller mill. The finest milled fraction with particle
122 size of 80 µm was used for the analysis.

123 Flour moisture, (%) was determined by an express method by drying 10g of flour for 60
124 min at 130°C according to BDS 754:1980/Amendment 4:2003/.

125 Wet gluten content (WG), (%) was determined by washing dough from a refined (by
126 moisture) amount of flour under a stream of running water (BDS 754:1980/Amendment 4:2003
127 and BDS EN ISO 21415- 1:2007).

128 Farinographic properties, such as the water absorption capacity of the flour, dough
129 development time, and dough stability, were measured using a Brabender farinograph (BDS ISO
130 5530 - 1:2004).

131 A single-phase dough mixing method was applied (Karadzhov, 2007; Lazova-Borisova,
132 2018), involving the mixing of flour (approximately 200 g, depending on the determined moisture
133 content), water, yeast, salt, and sugar in a special kneading machine. After dividing and rounding,
134 the dough pieces were left to proof in a chamber for 20 to 60 minutes at 32°C and 70% humidity.
135 This was followed by shaping, placing in baking trays, final proofing for 30 to 40 minutes, and
136 baking. The proofing and baking times varied depending on the composition of the pure flours and
137 the composite mixtures.

138

139 **Assessment of dough and bread samples properties**

140 The dough properties observed during handling were noted, using terms such as non-sticky and
141 suitable for machine processing, or sticky and unsuitable for machine processing. The baked bread
142 was evaluated for volume, crust color and structure, shape, crumb texture, and crumb color using
143 the following scales: crust color – 0 to 4.2 points; crumb color – 0 to 4.3 points; texture and shape
144 – 0 to 5 points (Haralampiev, 1970; Lazova-Borisova, 2018).

145 Organoleptic properties (aroma and taste) were identified through sensory analysis. (Nasir
146 et al., 2020; Nagy et al., 2023). The sensory evaluation was done by six participants – four women
147 and two men of different ages and with different eating habits. The bread was tasted the day after
148 baking. The tasting was carried out in the following way: the bread was cut into small pieces on a
149 plate and each variant was numbered. Between tasting the individual samples, each participant
150 rinsed with water. After the tasting, each participant described the taste and aroma of all variants
151 of the bread tasted. The bread volume was measured by the displacement method using small,
152 uniform grains with a volumeter (cm³) (BDS 3412:1979). The mass of the bread was measured by
153 weighing on an electronic scale (g). The height, H (cm) and the diameter of the loaf, D (cm), which
154 are necessary to calculate the dimensional stability coefficient (H/D), are determined by measuring
155 with a ruler.

156

157 **RESULTS AND DISCUSSION**

158 **Flour colour variation**

159 During laboratory milling of sorghum varieties and lines using a small roller mill, the bran layers
160 (pericarp and germ) were removed, thereby reducing tannin and phytic acid content. The milling
161 method used was quick and resulted in high flour yield (up to 70%), but it could cause starch
162 damage, negatively affecting the flour quality for bread preparation. The subsequent evaluation of
163 the obtained flour samples revealed differences in color. Compared to the wheat flour from the
164 Pchelina variety, characterized by high whiteness, the sorghum flour did not meet the whiteness
165 requirements. On the one hand, the color of sorghum flour is due to its higher ash content, and on

166 the other hand, the sorghum grain pericarp can vary in color from white to various shades of red,
167 yellow, and black, depending on genetic factors and environmental conditions (Akin et al., 2022).
168 Lines MBA-12 and MBA-24, classified as white-grained forms, produced flour with white to
169 grayish coloring. Flour from the other varieties and lines ranged from pink (Maxibel variety) to red
170 (Maxired variety and MR-12 and MR-24 lines) (Table. 2).

171

172 **Variations in dough properties**

173 The wet gluten content (WG) was highest in composites with 30% sorghum (Table 3; Fig. 1 - 2.A,
174 2.B, 2.C) and gradually decreased as the sorghum flour content increased to 50% (Table 3; Fig. 1 -
175 3.A, 3.B, 3.C) and 70% (Table 3; Fig. 1 - 4.A, 4.B, 4.C). Pure sorghum flour (100%) was gluten-
176 free (Table 3).

177 The flour quality depends on its water absorption capacity, which is associated with the
178 dough's rheological properties. Through farinographic analysis of hybrid flours, Dube et al. (2020),
179 Sibanda et al. (2015) and Nagy et al. (2023) found a reduction in water absorption due to sorghum
180 addition, a longer dough development time, and reduced dough stability due to the weakening of
181 the gluten network configuration during kneading. The authors attributed this primarily to the low
182 gluten content in sorghum-based flour mixtures.

183 In our study, we found that water absorption in composites with 30%, 50%, and 70%
184 sorghum was slightly higher than that of the control wheat flour and increased sharply in the 100%
185 sorghum flour variant. The likely reason for the higher absorption capacity of our tested composites
186 is the use of the finest-milled fraction of sorghum flour, which has higher water absorption. This

187 finding aligns with other researchers' results, which indicate that the degree of flour milling
188 significantly affects water absorption (Torres et al., 1993). According to Akajiaku et al. (2017), the
189 high-water absorption capacity of sorghum-based composites may also be due to the higher protein
190 and carbohydrate content in pure sorghum flour compared to wheat flour. This suggests that
191 selecting a sorghum variety with high protein and carbohydrate content could improve the water
192 absorption capacity of composite flours and enhance dough quality parameters.

193 As the sorghum content in hybrid flours increased, gluten content decreased, leading to
194 longer dough development times and reduced stability (Table 3).

195 The properties of the dough in our experiment showed that pure sorghum flour and the 70%
196 sorghum composite formed very sticky dough due to the absence or low gluten content, making
197 machine processing significantly difficult. The dough quality improved as the sorghum content
198 decreased. In the variant with 30% sorghum flour and 70% wheat flour, the dough was non-sticky
199 and easier to handle mechanically. Adding sorghum to standard white flour reduced the
200 extensibility and elasticity of the composite dough, a finding also noted by Sibanda et al. (2015).
201 The degree of softening of sorghum, particularly when used as a substitute in wheat dough,
202 generally increases as the proportion of sorghum flour increases (from over 27.6 to 60.1 at 70%
203 substitution) This indicates a weakening of the dough structure compared to pure wheat flour
204 (Hinar et al., 2014; Omer et al., 2025).

205

206

207 **Variations in baking qualities**

208 The baked bread was analyzed based on several parameters: loaf volume, height, diameter, shape
209 stability, surface, crust color, crumb texture, crumb color and (Table 4). Loaf volume decreased
210 significantly as the sorghum content in the flour mixtures increased. The lowest loaf values for this
211 indicator were measured for bread made from pure sorghum (Table 3). This was due to a correlation
212 between the physicochemical composition of sorghum flours and loaf volume. The low gluten
213 content in the composites reduced their water absorption capacity, which diminished their ability
214 to retain gases and lowered the dough's viscoelastic properties, resulting in reduced loaf volume
215 (Adzqia et al., 2023, Rumler et al., 2024). Bread made from pure wheat flour had a well-defined
216 shape with a smooth, shiny, golden-brown crust (Fig. 2 -1. A, 1. B, 1. C, 1. D). In the trials with
217 30% (Fig. 2-D) and 50% sorghum flour (Fig. 2 - C) in the composites, the bread crust structure was
218 closest to that of the control. The crust was smooth, with a color ranging from darker to light brown.
219 The formed bread had a slightly domed top crust and a regular shape. As the sorghum content in
220 the flour mixture increased to 70%, the bread surface became rougher, and the crust color darkened
221 (Fig. 2 - B). Bread baked from 100% sorghum flour did not meet any of the requirements for shape,
222 surface, or crust color (Fig. 2 -A).

223 The ratio between the height and diameter of the bread was used as an indicator of its shape
224 stability. The highest values of this coefficient were recorded in the variant with 30% sorghum
225 flour, with a trend of decreasing values as the gluten content in the flour mixtures decreased (Table
226 3).

227 The bread texture was evaluated using a five-point scale. Bread made from pure wheat flour
228 exhibited high elasticity, with evenly distributed thin-walled pores and a white crumb, receiving a
229 score of 4.9 points (Table 4; Fig. 3 - 1.A, 1.B, 1.C). Hybrid flours with varying sorghum content
230 resulted in decreased elasticity and the appearance of uneven pores with a coarse and moist crumb.
231 The color also changed, transitioning from white to grayish or reddish-brown as the sorghum
232 content increased to 70% (Table 4; Fig. 3 - D, B, C).

233 Bread made from 100% sorghum flour showed the poorest characteristics in terms of crumb
234 porosity, receiving a score no higher than 2 points (Table 4; Fig. 3-A). These results align with the
235 findings of Hugo et al. (2003), Onyango et al. (2011), Cappa et al. (2016), and Adepehin et al.
236 (2023), confirming that the best bread texture is achieved with composite flours containing up to
237 30% sorghum.

238 This suggests that adding sorghum beyond this threshold significantly reduces bread-
239 making quality, worsening the texture and decreasing the shape stability of the final bread.
240 Therefore, if the sorghum content in flour mixtures is to be increased, additional methods for
241 improving the texture and volume of the bread should be explored.

242 Sensory analysis indicated that sorghum bread had a specific smell, acidity, and astringency,
243 in contrast to the pleasant aroma and taste of wheat bread (Chaquilla-Quilca et al., 2024; Jeboa and
244 Urga, 2024). The main substances that influence the aroma and taste of bread are volatile aromatic
245 compounds released during the fermentation and thermal reactions that occur during the baking
246 process. Variants with 70% and 50% sorghum flour in the composites also showed deviations in
247 taste due to an unpleasant aroma and a slightly bitter aftertaste. No significant differences in aroma
248 and taste were observed in the bread containing 30% sorghum compared to the wheat control.

249 Similar results have been reported by other authors, whose studies indicate that the aroma and taste
250 of composite bread with 10% and 20% sorghum are closest to those of bread made from 100%
251 wheat flour (Carson et al., 2000; Sibanda et al., 2015; Tuhanioglu et al., 2023).

252

253 CONCLUSIONS

254 The present study on the bread-making qualities of sorghum flour shows that, regardless of
255 genotype, the best results were achieved with bread made from composite flour containing 30%
256 sorghum and 70% wheat. As the proportion of sorghum increases, the quality of the baked bread
257 deteriorates, and varietal characteristics become more pronounced. According to commercial and
258 consumer standards for bread production, sorghum flours from the MVA-5 and MVA-11 lines,
259 which are white to grayish in color, are preferred because they produce bread with crust structure,
260 crumb quality, and organoleptic properties similar to those of wheat products.

261 Our data on the chemical composition and bread-making characteristics suggest that
262 sorghum-wheat composites can be used in the production of various food products—bread,
263 breadsticks, rusks, crackers, and others. However, efforts should be made to improve the quality of
264 hybrid flours containing sorghum by reducing gluten content through the addition of various
265 ingredients and the application of traditional and innovative production technologies.

266 In Bulgaria, the consumption of low-gluten products containing sorghum is still not well
267 established. In contrast, in other European countries (Italy, Spain, France), there is a trend towards
268 expanding the production and consumption of foods containing hybrid flours with sorghum. In this
269 regard, the present study is part of a large-scale scientific program in our country aimed at using

270 sorghum not only as animal feed but also for inclusion in low-gluten flours for bakery production.
271 The goal of our scientific efforts is the wider adoption of sorghum-based products in the food
272 industry and the satisfaction of the growing consumer interest in this future crop as a healthy and
273 dietary food.

274

275 **CRedit AUTHORSHIP CONTRIBUTION STATEMENT**

276 **Sonya Doneva:** Performed all laboratory experiments and research, analyzed the data, and wrote
277 the manuscript. **Kalin Slanev:** Developed the project and supervised the field work, verified the
278 results, contributed to editing the manuscript.

279 **DECLARATION OF COMPETING INTEREST**

280 The authors declare that they have no known competing financial interests or personal relationships
281 that could have appeared to influence the work reported in this paper.

282 **ETHICS APPROVAL**

283 Not applicable.

284 **AVAILABILITY OF DATA AND MATERIALS**

285 Data will be made available on reasonable request from the corresponding author.

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290 No AI-assisted technologies were employed in the preparation of this manuscript. All content was
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427 Table 1. Chemical composition and grain color of sorghum varieties.

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Variants	Grain color	Moisture %	Crude protein %	Crude fats %	Crude fibers %	Mineral substances %	Ca %
Maxired	red	10.0	10.43	2.90	2.12	2.12	0.110
MR-24	red	10.0	9.33	3.59	2.06	1.90	0.170
MR-12	red	10.5	11.76	2.67	3.43	2.06	0.170
Maxibel	pink	9.5	10.08	2.24	2.99	1.03	0.170
MBA-5	grey	10.0	10.62	2.57	2.13	1.05	0.200
MBA-11	white	10.0	10.89	2.60	2.28	1.50	0.170

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443 Table. 2. Color of sorghum flour depending on ash content and genetic factors

Variants	Sorghum flour color
MBA-12	white to grayish
MBA-24	white to grayish
Maxibel	pink
Maxired	red
MR-12	red
MR-24	red

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457 Table 3. Average values of farinograph parameters of flour and dough from sorghum and sorghum-
 458 wheat composites for all analyzed sorghum types - Maxibel, Maxired, MBA-5, MBA-11, MR-12,
 459 and MR-24.

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Variants	Flour moisture, %	WG in 70% wheat, %	Water absorption capacity of flour, H ₂ O, (cm ³)	Dough development, (min)	Dough stability, (min)	Degree of dough softening, (FU)
100% wheat	10.8	30.5	45	1.5	8.7	13.0
100% sorghum	9.8 – 10.6	0.0	70-75	12.5-16.0	1.0	83.2
70% sorghum	10.2-10.5	1.5-2.8	60-67	8.3-12.0	1.2-1.4	60.1
50% sorghum	10.2-10.5	9.8-10.9	52-58	5.0-10.0	1.5-2.0	42.5
30% sorghum	10.2-10.7	17.4-19.1	47-50	3.6-4.8	1.8-2.4	27.6

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476 Table 4. Properties of baked bread from sorghum and sorghum-wheat composites

Variants	Loaf volume (cm ³)	H, (cm)	D, (cm)	Shape stability, H:D	Surface /Crust color (0-4.2)	Crumb texture (0-5)	Bread shape (0-5)	Crumb color (0-4.3)
100% Control	610	66	117	0.56	4.2	4.9	5.0	4.3
100% MBA-5	180	28	115	0.24	3.0	2.0	2.5	3.4
100% MBA-11	200	34	112	0.30	3.2	2.0	2.5	3.5
100% MR-12	165	26	128	0.20	2.6	2.0	2.5	3.0
100% MR-24	170	29	127	0.23	2.6	2.0	2.5	3.0
100% Maxibel	185	40	107	0.37	3.0	2.0	2.5	3.0
100% Maxired	175	35	108	0.32	2.6	2.0	2.5	2.8
70% MBA-5	190	37	118	0.31	3.2	2-2.5	2.5-3.0	3.4
70% MBA-11	205	36	111	0.32	3.4	2-2.5	2.5-3.0	3.4
70% MR-12	170	37	115	0.32	2.8	2-2.5	2.5-3.0	2.8
70% MR-24	175	36	111	0.32	2.8	2-2.5	2.5-3.0	2.8
70% Maxibel	190	32	115	0.28	3.2	2-2.5	2.5-3.0	3.0
70% Maxired	180	33	112	0.29	2.8	2-2.5	2.5-3.0	2.8
50% MBA-5	290	35	125	0.22	3.4	2.0-2.5	3.0-3.5	3.5
50% MBA-11	310	38	124	0.31	3.6	2.0-2.5	3.0-3.5	3.5
50% MR-12	285	40	125	0.32	3.0	2.0-2.5	3.0-3.5	3.0
50% MR-24	280	36	124	0.29	3.0	2.0-2.5	3.0-3.5	3.0
50% Maxibel	290	41	118	0.35	3.2	2.0-2.5	3-3.5	3.2
50% Maxired	285	37	129	0.29	3.0	2.0-2.5	3-3.5	2.8
30% MBA-5	320	51	106	0.48	4.0	2.5-2.8	4.0-4.2	3.7
30% MBA-11	330	50	107	0.47	4.0	2.5-2.8	4.0-4.2	3.9
30% MR-12	300	51	105	0.48	4.0	2.5-2.8	4.0-4.2	3.4

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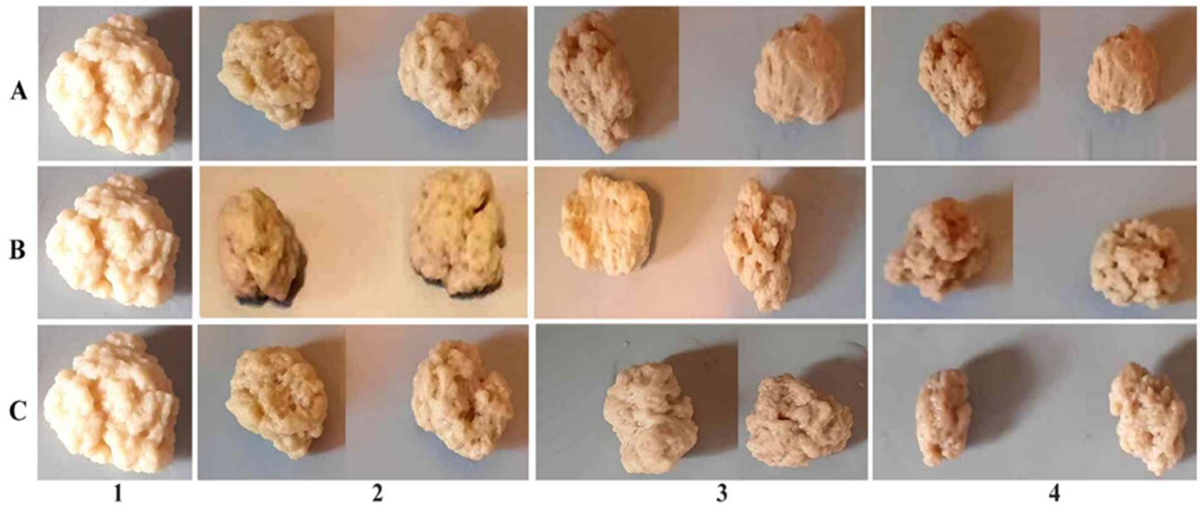
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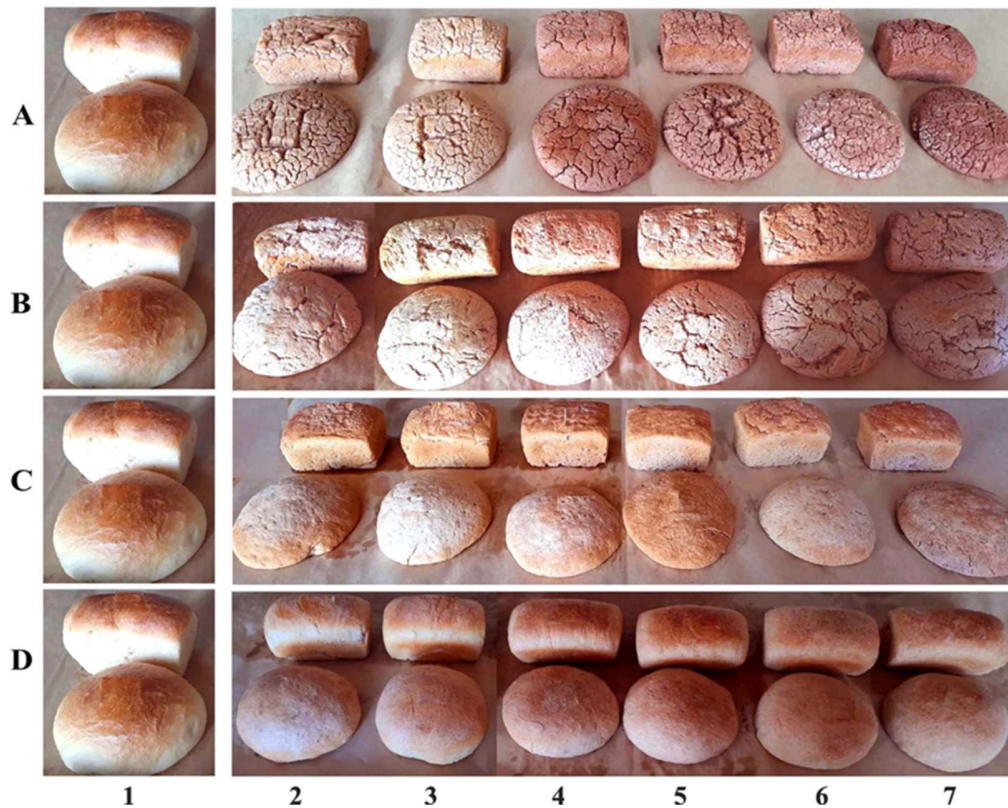
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485 **Figure. 1.** Washed pure gluten from flour. (A) 1. Control (100% wheat); 2. 30% MBA-5; 30%
486 MBA-11; 3. 50% MBA-5; 50% MBA-11; 4. 70% MBA-5; 70% MBA-11; (B) 1. Control (100%
487 wheat); 2. 30% MR-12; 30% MR-24; 3. 50% MR-12; 50% MR-24; 4. 70% MR-12; 70% MR-24;
488 (C) 1. Control (100% wheat); 2. 30% Maxibel; 30% Maxired; 3. 50% Maxibel; 50% Maxired; 4.
489 70% Maxibel; 70% Maxired



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491 **Figure. 2.** Bread shape, color and structure of the crust. (A) 100% sorghum flour bread; (B) 70%
492 sorghum flour bread; (C) 50% sorghum flour bread; (D) 30% sorghum flour bread: 1. Control
493 (100% wheat); 2. MBA-5; 3. MBA-11; 4. MR-12; 5. MR-24; 6. Maxibel; 7. Maxired

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497 **Figure 3.** Crumb texture and crumb color. (A) 100% sorghum flour bread; (B) 70% sorghum flour
498 bread; (C) 50% sorghum flour bread; (D) 30% sorghum flour bread: 1. Control (100% wheat); 2.
499 MBA-5; 3. MBA-11; 4. MR-12; 5. MR-24; 6. Maxibel; 7. Maxired