

1 **Assessment of the sanitary quality of precooked cereal-based foods produced in**
2 **Ouagadougou, Burkina Faso**

3

4 **Abstract**

5 Small-scale cereal-based food production companies have recently been growing in
6 Ouagadougou. The promoters of these companies do not always apply good hygiene practices
7 (GHP) during their activities, which can lead to the production of food of unsatisfactory
8 quality, which can threaten the health of consumers. In view of this observation, this study
9 was initiated with the aim of assessing the sanitary quality of four pre-cooked cereal-based
10 foods produced in Ouagadougou's city. Thus, 27 samples of these foods (rice and maize
11 couscous, millet and sorghum *dèguè*) were collected and sent to the laboratory.
12 Microbiological and physicochemical analyses using standard methods were performed on
13 these samples. The results obtained show that for all the samples of the four foods, the pH
14 varies from 6.20 ± 0.02 to 7.79 ± 0.01 while the water content varies from $4.80 \pm 0.72\%$ to
15 $9.19 \pm 0.01\%$. The dry matter content of the samples was between $90.00 \pm 0.01\%$ and
16 $95.20 \pm 0.07\%$. The water and oil absorption capacities of the samples vary from
17 $130.26 \pm 5.10\%$ to $162.02 \pm 4.20\%$ and from $90.09 \pm 0.00\%$ to $115.05 \pm 7.03\%$ %. The loads of
18 Total Aerobic Mesophilic Flora (TAMF) and Yeasts and Molds (YM) vary, respectively,
19 from $1.33 \pm 0.71 \times 10^2$ CFU/g to $1.24 \pm 0.54 \times 10^4$ CFU/g and from <10 CFU/g to $2.20 \pm 0.14 \times 10^3$
20 CFU/g. For most samples, total coliforms (TC) and Thermotolerant Coliforms (TTC) loads
21 were less than 10 CFU/g. *Salmonella-Shigella* was absent from all samples. Referring to the
22 standards, for all the germs studied, 100% of the rice couscous samples, 83.34% of the millet
23 *dèguè* samples, 66.66% of the sorghum *dèguè* samples, and 77.78% of the maize couscous
24 samples presented satisfactory microbiological quality.

25 **Keywords:** Precooked foods, cereals, quality, microbiology, physico-chemistry,
26 Ouagadougou

27 **Introduction**

28 Cereals occupy a primordial place in the global agricultural system. They are considered to be
29 the main source of human and animal nutrition [1]. In Africa, cereals (maize, rice, sorghum,
30 millet, fonio) constitute a staple diet for most populations [2]. According to the results of the
31 2013 agricultural campaign, cereal production in Burkina Faso mainly focused on maize, rice,
32 sorghum, millet, and fonio [3]. The demographic explosion in urban centers and lifestyles
33 changing are creating new demands on city dwellers. They are on the lookout for quality
34 products, but they are also looking for cereals that are easy and quick to prepare [4]. Thus, the
35 proliferation of artisanal structures for the production of precooked cereal-based foods has
36 occurred in urban centers. However, the inability to observe the requirements for their
37 preparation, packaging, and storage subjects them to microbial contamination, which poses a
38 health risk to consumers [5], [6]. Therefore, some of these structures often produce food
39 whose quality is not always satisfactory, exposing consumers to food-borne diseases.
40 Foodborne diseases affect 600 million people each year worldwide, and 420,000 peoples die
41 from them, including 125,000 children under the age of five [7]. In Africa, annually, 91
42 million people suffer from foodborne diseases and approximately 137000 die from them,
43 representing 1/3 of global mortality due to foodborne diseases [7]. Similarly, according to
44 Tabassum et al. [8], foodborne diseases are an important cause of morbidity and mortality
45 because millions of people fall ill and many die after ingesting food unfit for consumption. In
46 addition, the production of poor quality food results in a loss of competitiveness and money
47 for food production structures and consumer mistrust [9]. In view of these problems linked to
48 unsanitary foods, this study was initiated to assess the sanitary quality of precooked cereal-
49 based foods produced artisanally in Ouagadougou.

50 **Materials and methods**

51 **Sampling**

52 Samples were obtained from production sites located in Ouagadougou, Burkina Faso.
53 Therefore, 27 samples of the four precooked cereal-based foods (rice and maize coucous,
54 sorghum and millet *dèguè*), initially packaged in bags of 500g, were taken during different
55 productions. These samples were then transported and stored in the laboratory for
56 physicochemical and microbiological analyses.

57 **Physico-chemical analyses**

58 **pH**

59 The pH was determined according to the AOAC [10] method using a pH meter (HANNA
60 instruments). Thus, 10 g of each sample were taken and introduced into a beaker containing
61 50 mL of distilled water. The pH meter electrode was then rinsed with distilled water and
62 introduced into the mixture after homogenization. The pH value was read on the pH meter
63 screen after stabilization. For each sample, measurements were made in triplicate.

64
65 **Dry matter and water content**

66 To quantify the dry matter, 5 g of each sample were introduced into an empty crucible of
67 known mass. The whole mixture was placed in an oven at 105°C for 4 h. Then, each sample
68 was cooled and the crucible mass containing the sample was weighed. For each sample,
69 measurements were made in triplicate. The dry matter content was calculated using the
70 following formula:

$$MS (\%) = \frac{MF - M0}{PE} * 100$$

71 Legend : MF : Mass of crucible and sample in g ; PE : Test portion in g ; M0 : Mass of empty
72 crucible in g

73 The water content H (%) was deduced using the following formula:

74 $H (\%) = 100 - MS (\%)$

75 With: MS (%) : dry matter ; H (%) : water content

76

77 **Water absorption capacity (WAC)**

78 The water absorption capacity was determined according to the method described by

79 Rodriguez-Ambriz et al. [11].

80 **Oil Absorption Capacity (OAC)**

81 The Oil absorption capacity (OAC) was determined according to the method described by Lin

82 and Zayas [12].

83 **Microbiological analyses**

84 **Preparation of culture media**

85 The culture media used in this study were prepared according to the manufacturer's

86 instructions. The obtained preparations were homogenized and sterilized at 121°C for 15 min

87 (except *Salmonella-Shigella* medium). These preparations were then poured into Petri dishes.

88 **Preparation of dilutions and Seeding**

89 Under sterile conditions, 10 g of each sample were added to 90 mL of physiological water.

90 The mixture obtained (dilution 10^{-1}) is then diluted in a cascade up to dilution of 10^{-4} .

91 For each sample, 0.1 mL of the appropriate dilutions was inoculated onto the culture media

92 previously poured into the Petri dishes and spread using a sterile pipette. These Petri dishes

93 were turned over and incubated at the time and temperature indicated in Table 1.

94 Table 1. Microorganisms, culture media and incubation conditions

Microorganism	Standard	Culture medium	Temperature and incubation time
TAMF	ISO4833(2003) [13]	PCA	37 °C for 24 hours
TC	ISO4832(2006) [14]	EMB	37 °C for 24 hours
TTC	ISO4832(2006) [14]	EMB	44 °C for 24 hours

YM	NF V08-059 (2002) [15]	SCA	30 °C for 120 hours
SS	ISO6579(2002) [16]	SS Agar	37 °C for 120 hours

95 TMAF: Total Mesophilic Aerobic Flora; TC: Total Coliform; TTC: Thermotolerant
 96 Coliforms; YM: Yeasts and Molds; SS: *Salmonella-Shigella*; PCA : Plate count Agar, EMB :
 97 Eosin Methylen Blue, SCA : Sabouraud Chloramphenicol Agar, **SS** : *Salmonella-Sighella*
 98

99 The search for *Salmonella-Shigella* was carried out following the steps below:

100 - Pre-enrichment: 25 g of each sample were introduced into 225 mL of buffered peptone water
 101 and incubated at 37°C for 24 h.

102 - Enrichment in liquid selective medium: 1 mL of the pre-enriched broth was introduced into
 103 9 mL of Rappaport-Vassiliadis (RV) broth and incubated at 37°C for 24 h.

104 - *Salmonella-Shigella* isolation: A Pasteur pipette dipped in the enrichment medium was used
 105 to inoculate *Salmonella-Shigella* agar (SS agar). The plates were then incubated at 37°C for
 106 24 h.

107 Enumeration

108 The number of microorganisms in CFU/g of each sample was determined according to
 109 standard ISO 4833-2 (2013) [17]:

- 110 • For Petri dishes with a number of colonies between 15 and 300, the following formula
 111 was used:

$$N \left(\frac{\text{CFU}}{\text{g}} \right) = \frac{\sum C}{V(n_1 + 0.1n_2)d}$$

112 N : number of microorganisms in CFU/g of product

113 $\sum C$: sum of colonies

114 V : volume of inoculum placed in each Petri dishes in mL

115 n1 : number of Petri dishes retained at the first dilution

116 n2 : number of Petri dishes retained at the second dilution

117 d : lowest dilution rate retained

118 • For Petri dishes whose colony sum is less than 15, the following formula was used:

$$N = \frac{\sum C}{V * d * n}$$

119 • For Petri dishes in which no colonies were observed, the number of microorganisms
120 was considered to be less than 1/d (N < 1 / d).

121 **Results and discussion**

122 **Physico-chemical characteristics**

123 **pH**

124 During this study, very little variation in pH was observed for the three types of food (Table
125 2). For these foods, the average pH were 6.30±0.01, 6.33±0.06 and 6.25±0.02 respectively for
126 rice couscous, millet *dèguè* and sorghum *dèguè*. However, maize couscous has the highest
127 pH, with an average of 7.49±0.17. The relatively high pH of maize couscous can be explained
128 by the frequent use of potash during maize flour production. The pH values obtained during
129 this study are higher than those reported by Angaman et al. [18] and Koné et al. [19], with
130 values of 4.92 and 4.75 in germinated and non-germinated flours, respectively. The pH values
131 obtained during this study are similar to those reported by Sika et al. [20] and Houssou et al.
132 [21], which were respectively 6.75±0.25 and 6.78±0.02 in maize flour **sumplemented** with
133 **safou (*Dacryodes edulis*)** and *yèkè-yèkè* (maize couscous). The pH of the samples studied are
134 generally close to neutral pH, which can be a favorable factor for microbial growth and
135 therefore food spoilage.

136 **Water content**

137 The rice couscous samples had very low water contents of approximately 5% (Table 2) with
138 an average of 5.05±0.26%. The millet and sorghum *deguè* samples had similar water contents
139 with respective averages of 5.87±0.27% and 6.39±0.32%. The maize couscous samples

140 presented the highest water content, with an average of $8.57 \pm 0.27\%$. This significant variation
141 in water content can be explained by the drying conditions. Other authors have reported water
142 contents similar to those recorded in this study. Thus, after the analysis of three flour samples,
143 a humidity varying from $8.30 \pm 0.10\%$ to $8.60 \pm 0.17\%$ was reported by Yapi et al. [22].
144 Similarly, Houssou et al. [21] found a water content of $8.25 \pm 0.05\%$ in *yèkè-yèkè*. Water
145 contents lower than those obtained in this study, ranging from 3.33 g/100g to 4.66 g/100g),
146 were also reported by Kone et al. [19] in infant flours composed of dehydrated *attiéké* and
147 cashew nuts. N’Goran et al. [23], obtained results from white flours indicating average water
148 content values of between $21.0 \pm 10.16\%$ and $39.7 \pm 2.02\%$. Humidity levels below 10% are
149 recommended to preserve the cereal-based product for a reasonable period [24]. Thus, the
150 samples of the foods studied could be easily preserved.

151 **Dry matter**

152 The dry matter content was very high in rice couscous, millet, and sorghum *dèguè*, with
153 respective averages of $94.94 \pm 0.26\%$, $94.12 \pm 0.27\%$ and $93.59 \pm 0.32\%$. For maize couscous,
154 the dry matter content was relatively lower, with an average of $91.42 \pm 0.27\%$. However, these
155 contents are sufficiently high to allow good conservation of this product. Other authors have
156 reported dry matter contents close to those of the present study with values of $91.09 \pm 0.99\%$ in
157 germinated corn flour [18] and $92.80 \pm 0.57\%$ [20] in maize flour supplemented with *safou*.

158 **Water absorption capacity**

159 The WACs of the samples of the four foods are presented in Table 2. WACs vary little from
160 one sample to another and from one food to another. The WAC values obtained during this
161 study are similar to those reported by Kaur and Singh [25], Ghavidel and Prakash [26], and
162 Angaman et al. [18], respectively, with 128% in cowpea yam flour, 136% in chickpea flour
163 and $116.766 \pm 0.462\%$ in sprouted maize flour. However, Gampoula et al. [27] reported a
164 WAC of 191.58% in yam-based infant flour. Indeed, foods with high water absorption
165 capacity have more hydrophilic constituents such as polysaccharides [18]. According to

166 Nelson-Quartey et al. [28], the presence of lipids in food reduces the binding capacity of
167 water to particular substances, thus limiting WAC.

168 **Oil absorption capacity**

169 The oil absorption capacities of the analyzed couscous samples are presented in Table 2. The
170 OAC values are similar for the two types of couscous and vary from $90.09 \pm 00\%$ to
171 $115.05 \pm 07.03\%$. The values obtained during this study are similar to those reported by
172 Angaman et al [18] and Gampoula et al. [27], respectively $109.37 \pm 9.261\%$ in sprouted maize
173 flour and 93.33% in yam-based infant flour. However, other authors found higher OAC of
174 $167.78 \pm 4.61\%$ to $188.62 \pm 6.62\%$ in foods [22].

175 According to Assielou et al. [29], a high oil absorption capacity is due to the presence of non-
176 polar amino acids in flours. Oil absorption capacity is important in food design because fat
177 acts as a flavor preserver, increases the palatability of foods, and enhances mouthfeel [30]
178 [31]. In addition, OAC is an important property in food preservation because it prevents the
179 development of oxidative rancidity [32].

180

Table 2. Physico-chemical characteristics of precooked foods

Food	Sample	Water content (%)	Dry matter (%)	WAC (%)	OAC (%)	pH
Rice couscous	E1	4.80±0.72 ^a	95.20±0.72 ^a	157.02±5.00 ^a	105.01±10.00 ^{abc}	6.29±0.00 ^c
	E2	5.53±0.61 ^a	94.47±0.61 ^a	154.04±4.02 ^{ab}	110.02±08.01 ^{ab}	6.29±0.01 ^c
	E3	5.13±0.61 ^a	94.87±0.61 ^a	138.02±5.00 ^c	95.01±11.00 ^c	6.33±0.01 ^a
	E4	4.87±0.50 ^a	95.13±0.50 ^a	136.05±7.03 ^c	112.03±09.02 ^{ab}	6.31±0.01 ^b
	E5	4.93±0.61 ^a	95.07±0.61 ^a	162.02±4.20 ^a	102.01±00.00 ^{bc}	6.32±0.01 ^{ab}
	E6	5.07±0.70 ^a	94.93±0.70 ^a	145.08±6.06 ^{bc}	115.05±07.03 ^a	6.31±0.01 ^b
Maize couscous	E1	8.37±0.04 ^a	91.63±0.04 ^a	145.29±4.01 ^{de}	110.11±10.01 ^b	7.79±0.01 ^f
	E2	8.32±0.02 ^a	91.68±0.02 ^a	150.30±6.01 ^e	100.10±00.00 ^b	7.50±0.01 ^d
	E3	8.45±0.02 ^a	91.55±0.02 ^a	135.27±5.01 ^{ab}	110.15±10.04 ^b	7.41±0.01 ^c
	E4	8.46±0.16 ^a	91.54±0.16 ^a	140.28±0.00 ^{cd}	110.31±11.01 ^b	7.37±0.01 ^b
	E5	8.40±0.03 ^a	91.60±0.03 ^a	130.26±5.01 ^a	100.10±00.00 ^b	7.38±0.01 ^b
	E6	8.60±0.00 ^b	91.40±0.00 ^b	135.27±5.01 ^{ab}	90.09±00.00 ^a	7.36±0.01 ^b
	E7	8.65±0.12 ^{bc}	91.35±0.12 ^{bc}	135.27±5.01 ^{bc}	100.10±09.01 ^b	7.38±0.01 ^b
	E8	9.19±0.01 ^d	90.00±0,01 ^d	130.26±0.00 ^a	90.09±00.00 ^a	7.26±0.02 ^a
	E9	8.76±0.01 ^c	80.24±0.01 ^c	140.28±5.01 ^{bc}	101.10±00.00 ^b	7.72±0.02 ^e
Millet <i>dèguè</i>	E1	5.66±0.47 ^a	94.33± 0.47 ^a	150.03±0.00 ^a	ND	6.36±0.04 ^a
	E2	6.06±0.60 ^a	93/93±0.60 ^a	150.03±0.00 ^a	ND	6.20±0.02 ^a
	E3	5.87±0.30 ^a	94.13±0.30 ^a	150.03±0.00 ^a	ND	6.37±0.02 ^a
	E4	6.33±0.50 ^a	93.67±0.50 ^a	150.03±0.00 ^a	ND	6.39±0.01 ^a
	E5	5.73±0.37 ^a	94.27±0.37 ^a	150.03±0.00 ^a	ND	6.32±0.00 ^a
	E6	5.60±0.56 ^a	94.40±0.56 ^a	150.03±0.00 ^a	ND	6.34±0.02 ^a
Sorghum <i>dèguè</i>	E1	6.53±0.71 ^a	93.46±0.71 ^a	160.32±06.53 ^a	ND	6.23±0.02 ^c
	E2	6.27±0.88 ^a	93.73±0.88 ^a	145.29±11.23 ^a	ND	6.29±0.01 ^a
	E3	6.33±0.71 ^a	93.67±0.71 ^a	148.32±02.51 ^a	ND	6.23±0.01 ^c
	E4	6.93±0.71 ^a	93.07±0.71 ^a	150.30±12.24 ^a	ND	6.27±0.01 ^{ab}
	E5	6.40±0.66 ^a	93.60±0.66 ^a	160.15±03.16 ^a	ND	6.23±0.00 ^c
	E6	5.93±0.71 ^a	94.06±0.71 ^a	150.12±05.23 ^a	ND	6.25±0.00 ^{bc}

In the same column, for each type of food, the values which have the same superscript letter are not significantly different at the threshold of p=0.05

Principal component analysis

Figure 1 illustrates the correlation of the variability of physicochemical and technological parameters depending on the different samples of precooked foods used in this study. Principal component analysis shows that the parameters taken into account in our study can be represented on two axes depending on the different samples considered. The two axes summarize 90.34% of the information in Figure 1. The F1 axis represents 75.28% of the observed variability and the F2 axis, 15.06%.

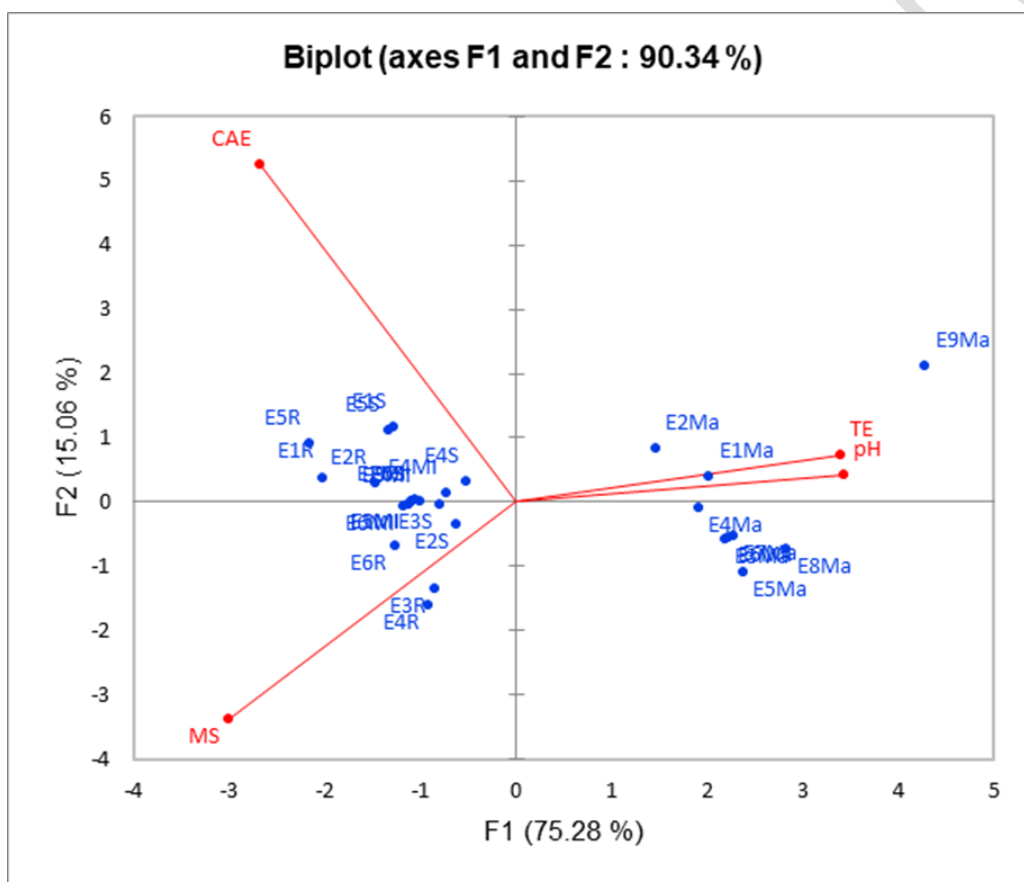


Figure 1: Result of principal component analysis of physicochemical and technological parameters of precooked foods

1 **Microbiological characteristics**

2

3 **Total Mesophilic Aerobic Flora**

4 The results showed that the Total Aerobic Mesophilic Flora (TAMF) loads of samples from
5 different foods were relatively similar (Table 3). TAMF loads of rice couscous, millet and
6 sorghum *dèguè* samples varied from $1.33\pm 0.71\times 10^2$ CFU/g to $8.00\pm 5.55\times 10^2$ CFU/g,
7 $1.40\pm 0.28\times 10^3$ CFU/g to $2.57\pm 0.12\times 10^3$ CFU/g and $1.00\pm 0.90\times 10^3$ CFU/g to $6.15\pm 5.85\times 10^3$
8 CFU/g respectively. Maize couscous samples showed relatively higher loadings than the other
9 three foods. This could be explained by the fact that maize couscous samples had higher water
10 contents than other foods. Other authors have found TAMF loadings similar to those recorded
11 in this study. Thus, loads of aerobic mesophilic germs varying from 2.09×10^2 CFU/g to
12 2.54×10^2 CFU/g were found in flours [20]. Similarly, Houssou et al. [21] obtained TAMF
13 loads of around 4.2×10^4 CFU/g. However, other authors have reported particularly high
14 TAMF loads of 1.8×10^9 CFU/g in flours [23]. The Codex Stan 74 [33] set a limit of 10^5
15 CFU/g in infant flour. Thus, referring to this limit, all the food samples studied were of
16 satisfactory quality.

17 **Yeasts and molds**

18 Yeast and mold loadings were generally similar in the samples of the four food types (Table
19 3). These loads are generally around 10^2 CFU/g. A few rare samples have loads lower than 10
20 CFU/g. The loads obtained during this study are similar to those reported in other studies.
21 Thus, Sika et al. [20] reported fungal loads that varied between 3.4×10^1 CFU/g and 3.8×10^1
22 CFU/g. Similarly, Houssou et al. [21] reported a yeast and mold load of 5.0×10^1 CFU/g in
23 infant flour. However, other authors have obtained much higher yeast and mold loads during
24 their studies. Therefore, according to Yao et al. [34], the mold load in the three samples
25 obtained just after grinding of the grains varied from 4.6×10^5 CFU/g to 5.6×10^5 CFU/g.

26 During a study examining the microbiological quality of flours, yeast and mold loads of
27 5.6×10^6 CFU/g and 1.9×10^8 CFU/g, were reported by N’Goran et al. [23]. According to
28 Codex Stan 74 [33], which sets the limit of 10^3 CFU/g of yeasts and molds in infant flours, 1
29 sample of maize couscous, 2 samples of millet dèguè, and 2 samples of sorghum dèguè are of
30 unsatisfactory quality.

31 **Total and thermotolerant coliforms**

32 For all samples of the four foods, the total and thermotolerant coliform loads were less than
33 10 CFU/g. Only three samples of maize couscous showed higher loads for these two types of
34 bacteria (Table 3). The presence of coliforms in certain samples demonstrates non-compliance
35 with hygiene rules in the production of the foods studied. N’Goran et al. [23] reported much
36 higher total and fecal coliform loads than those of the three maize samples in this study.
37 These loads were 1.3×10^6 and 7.0×10^5 CFU/g for total and thermotolerant coliforms,
38 respectively. However, during a study on infant flour samples, fecal coliforms were not
39 detected according to Sika et al. [20]. Similarly, total coliform loads <1 were reported in a
40 study by Houssou et al. [21]. Referring to which sets a limit of 10^3 CFU/g for total and fecal
41 coliforms in infant flour, only two samples of maize couscous are of unsatisfactory quality.

42 ***Salmonella–Shigella***

43 During this study, *Salmonella–Shigella* were not found in any of the samples (Table 3). Thus,
44 all samples of the four foods were of satisfactory quality for *Salmonella–Shigella*. These
45 results are similar to those reported by Sika et al. [20] and Angaman et al. [18]. However,
46 during a study on the evaluation of the sanitary quality of flours, N’Goran et al. [23]
47 demonstrated the presence of *Salmonella* in 2 maize flour samples.

48

Food	Sample	TMAF (CFU/mL)	TC (CFU/g)	TTC (CFU/g)	YM (CFU/g)	SS (in 25 g)	Global appreciation
Rice couscous	E1	1.90±1.30×10 ^{2ab}	<10	<10	1.20±0.25×10 ^{2ab}	Absent	Satisfactory
	E2	4.20±2.40×10 ^{2ab}	<10	<10	3.86±2.10×10 ^{2a}	Absent	Satisfactory
	E3	8.00±5.55×10 ^{2a}	<10	<10	2.00±0.41×10 ^{2ab}	Absent	Satisfactory
	E4	7.20±5.95×10 ^{2ab}	<10	<10	3.50±2.86×10 ^{2ab}	Absent	Satisfactory
	E5	3.71±1.07×10 ^{2ab}	<10	<10	2.00±0.57×10 ^{2ab}	Absent	Satisfactory
	E6	1.33±0.71×10 ^{2b}	<10	<10	1.07±0.23×10 ^{2b}	Absent	Satisfactory
Maize couscous	E1	1.24±0.54×10 ^{4c}	7.33±4.10×10 ^{3a}	5.15±2.27×10 ^{3a}	1.82±0.80×10 ^{3b}	Absent	Non-satisfactory
	E2	4.60±2.37×10 ^{3ab}	3.33±1.44×10 ^{2b}	1.33±0.58×10 ^{2b}	2.67±1.15×10 ^{2a}	Absent	Satisfactory
	E3	4.67±2.62×10 ^{3ab}	<10	<10	4.67±2.52×10 ^{2a}	Absent	Satisfactory
	E4	3.21±1.40×10 ^{3ab}	<10	<10	2.67±1.15×10 ^{2a}	Absent	Satisfactory
	E5	1.81±1.07×10 ^{3ab}	<10	<10	4.00±1.73×10 ^{2a}	Absent	Satisfactory
	E6	9.69±5.55×10 ^{2ab}	<10	<10	<10	Absent	Satisfactory
	E7	7.51±3.77×10 ^{3b}	3.57±2.56×10 ^{3b}	2.67±1.15×10 ^{2b}	2.67±1.53×10 ^{2a}	Absent	Non-satisfactory
	E8	4.67±2.02×10 ^{2a}	<10	<10	2.67±1.53×10 ^{2a}	Absent	Satisfactory
	E9	1.33±0.57×10 ^{2a}	<10	<10	<10	Absent	Satisfactory
Millet dèguè	E1	1.40±0.28×10 ^{3c}	<10	<10	4.50±1.06×10 ^{2d}	Absent	Satisfactory
	E2	1.60±0.35×10 ^{3bc}	<10	<10	8.00±2.1×10 ^{2cd}	Absent	Satisfactory
	E3	2.57±0.12×10 ^{3a}	<10	<10	1.00±0.28×10 ^{3bc}	Absent	Satisfactory
	E4	2.50±0.38×10 ^{3a}	<10	<10	1.50±0.14×10 ^{2a}	Absent	Non-satisfactory
	E5	2.20±0.24×10 ^{3ab}	<10	<10	7.00±0.14×10 ^{2cd}	Absent	Satisfactory
	E6	2.10±0.80×10 ^{3abc}	<10	<10	1.40±0.38×10 ^{2ab}	Absent	Non-satisfactory
Sorghum couscous	E1	2.35±0.50×10 ^{3ab}	<10	<10	1.60±0.15×10 ^{3b}	Absent	Satisfactory
	E2	2.20±0.40×10 ^{3ab}	<10	<10	2.200±0.2×10 ^{3a}	Absent	Non-Satisfactory
	E3	1.00±0.90×10 ^{3b}	<10	<10	8.0±1.5×10 ^{2d}	Absent	Satisfactory
	E4	2.25±0.75×10 ^{3ab}	<10	<10	2.00±0.1×10 ^{3a}	Absent	Satisfactory
	E5	6.15±5.85×10 ^{3a}	<10	<10	4.00±1.0×10 ^{2e}	Absent	Satisfactory
	E6	2.55±0.85×10 ^{3ab}	<10	<10	1.10±0.1×10 ^{3c}	Absent	Non-Satisfactory

Table 3. Microbiological characteristics of precooked foods

In the same column, for each type of food, the values which have the same superscript letter are not significantly different at the threshold of p=0.05

UNDER PEER REVIEW

Overall appreciation of the microbiological quality of samples

Taking into account all the microorganisms studied during this work, 22.22% (2/9) of the maize couscous samples, 16.66% (1/6) of the millet *dèguè* samples, and 33.33 % (2/6) of the sorghum *dèguè* samples were of unsatisfactory quality. All rice couscous samples were of satisfactory quality. For the samples of the four foods studied, 18.51% (6/27) were of unsatisfactory quality (Table 3). Thus, 81.41% of the samples used in this study had satisfactory microbiological quality. This high level of quality is linked to the low loads of microorganisms generally observed in the samples. These low loads could be explained by the very low humidity level in the different food samples studied [20]. Likewise, according to other authors such as Tarhouni et al. [20], cooking/drying coupling during food production would allow a significant reduction in the load of aerobic mesophilic germs and fungi. This could also explain the low microbial loads in the studied foods.

Conclusion

This study showed that precooked foods such as rice and maize couscous and millet and sorghum *dèguè* have similar physicochemical and technological characteristics, which are generally acceptable. It also shows that these foods have satisfactory microbiological quality in general, especially in the case of rice couscous. However, some samples had unsatisfactory quality for yeasts, molds, and coliforms. This means that we must raise awareness and train producers of these foods to further increase the quality of precooked foods produced in Ouagadougou.

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