

Effect of endogenous lipids and proteins on the antioxidant and pasting properties of sorghum flour

Irondi E.A.*, Adewuyi A.E. and Aroyehun T.M.



Department of Medical Biochemistry and Pharmacology, Kwara State University, Malete, P.M.B. 1530, Ilorin, Nigeria

•Correspondence: emmanuel.irondi@kwasu.edu.ng; Tel.: +2348034870657

INTRODUCTION

Sorghum [*Sorghum bicolor* (L.) Moench] is a major cereal for millions of poor people in Semi-Arid Tropics regions of Africa, Asia, and Latin America (Correia et al., 2010), where it serves as an important source of calorie and protein. Its flour is gluten-free, and therefore, is an alternative for people allergic to gluten. In addition, whole sorghum grain contains high levels of bioactive constituents such as polyphenols that are beneficial to health (Irondi et al., 2019). With these nutritive and nutraceutical qualities, sorghum could be a viable staple for ending hunger, achieving food security and improved nutrition, and promoting sustainable agriculture, as enunciated by the second UN sustainable development goal. However, flour matrix interactions may impact its bioactivities and food applications. As previously noted by Zhang and Hamaker (2003), the study of such interactions can boost the understanding of their functionalities in real food systems and provide useful information for the food industry. Hence, this study evaluated the effect of endogenous lipids and proteins on the antioxidant and pasting properties of sorghum flour.

RESEARCH METHODOLOGY

Sample (1 kg) of red sorghum grains (Figure 1) was sorted, ground into flour, packed hermetically in an opaque plastic container, and stored at 4°C during analysis. Endogenous lipids and/or proteins were removed from different portions (500 g each) of the flour to obtain defatted, deproteinized, and defatted-deproteinized flours; with an untreated portion serving as control. The bioactive constituents (total phenolics, tannins, flavonoids, saponins and anthocyanins) levels; antioxidant activity (ABTS*+ [2,2-azinobis (3-ethyl-benzothiazoline-6-sulfonic acid) radical cation] and DPPH* [2,2-diphenyl-2-picrylhydrazyl radical] scavenging activities, reducing power and Fe²⁺ chelating capacity); starch and amylose contents; and pasting properties of the treated and control flours were determined. Results of triplicate tests were analyzed using one-way ANOVA, followed by LSD test at 95% confidence level.

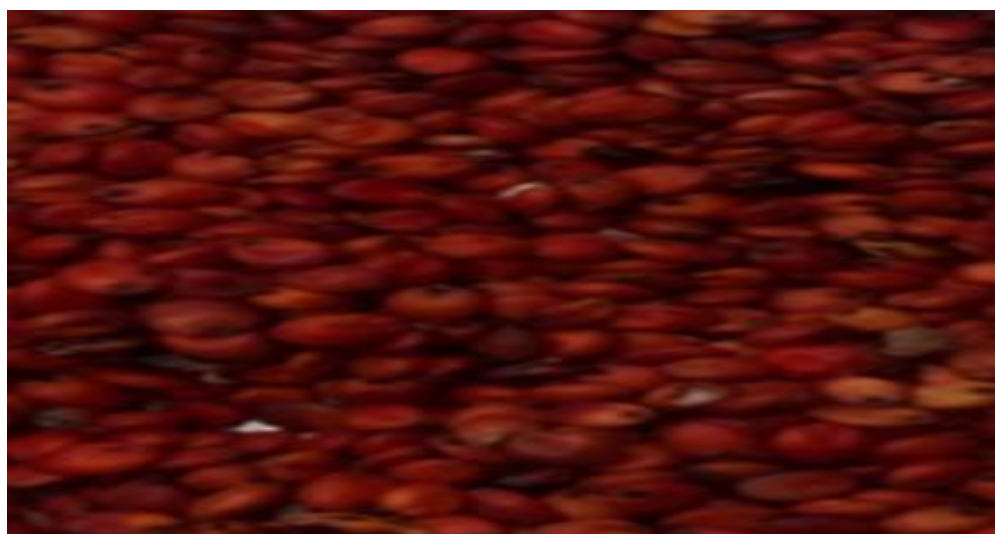


Figure 1. Sample of red sorghum grains

RESULTS AND DISCUSSION

Table 1. Bioactive constituents levels of control, defatted, deproteinized, and defatted-deproteinized sorghum flour

Flour	Total Phenolics (GAE mg/g)	Tannins (TAE mg/g)	Total Flavonoids (QE mg/g)	Total Saponins (DE mg/g)	Total anthocyanins (CGE mg/g)
Control	7.48 ± 0.51 ^a	8.23 ± 0.62 ^a	4.69 ± 0.04 ^a	3.74 ± 0.04 ^a	9.35 ± 0.60 ^a
Defatted	3.67 ± 0.02 ^b	4.03 ± 0.23 ^b	2.30 ± 0.08 ^b	1.83 ± 0.01 ^b	4.58 ± 0.30 ^b
Deproteinized	2.24 ± 0.13 ^c	2.47 ± 0.11 ^c	1.41 ± 0.01 ^c	1.12 ± 0.01 ^c	2.80 ± 0.11 ^c
Defatted-deproteinized	1.54 ± 0.06 ^d	1.69 ± 0.08 ^d	0.97 ± 0.04 ^d	0.77 ± 0.03 ^d	1.93 ± 0.06 ^d

Mean values having different superscript letters along the same column vary significantly ($p < 0.05$). TAE, tannic acid equivalent; QE, quercetin equivalent; DE, diosgenin equivalent; CGE, cyanidin glucoside equivalents

Table 2. Antioxidant activity of control, defatted, deproteinized, and defatted-deproteinized sorghum flour

Flour	ABTS*+ scavenging ability (mmol TEAC/g)	DPPH* SC ₅₀ (µg/mL)	Fe ²⁺ chelation CC ₅₀ (µg/mL)	Reducing power (mg GAE/g)
Control	7.52 ± 0.45 ^a	8 ± 0.98 ^d	11.34 ± 0.92 ^d	68.38 ± 1.63 ^a
Defatted	5.26 ± 0.23 ^b	11.81 ± 0.87 ^c	15.81 ± 0.83 ^c	65.36 ± 1.21 ^b
Deproteinized	4.02 ± 0.19 ^c	13.49.58 ± 0.74 ^b	17.58 ± 1.11 ^b	61.81 ± 1.06 ^c
Defatted-deproteinized	3.23 ± 0.13 ^d	16.37 ± 1.03 ^a	19.64 ± 1.42 ^a	56.29 ± 1.51 ^d
Ascorbic acid	-	6.08 ± 0.57 ^e	8.89 ± 0.91 ^e	-

Mean values having different superscript letters along the same column vary significantly ($p < 0.05$). TEAC: Trolox equivalent antioxidant capacity; SC₅₀: extract conc. that scavenged 50% of DPPH*; CC₅₀: extract conc. that chelated 50% of Fe²⁺; GAE: Gallic acid equivalent.

Table 3. Starch, amylose and amylopectin levels of control, defatted, deproteinized, and defatted-deproteinized sorghum flour

Flour	Starch (%)	Amylose (%)	Amylopectin (%)	Amylose/ amylopectin
Control	47.72 ± 0.31 ^d	22.67 ± 0.22 ^d	77.34 ± 0.22 ^a	0.30 ± 0.01 ^b
Defatted	59.58 ± 0.33 ^b	26.74 ± 0.30 ^b	73.26 ± 0.30 ^c	0.37 ± 0.02 ^a
Deproteinized	52.99 ± 0.31 ^c	24.01 ± 0.52 ^c	75.99 ± 0.52 ^b	0.32 ± 0.01 ^b
Defatted-deproteinized	70.99 ± 0.34 ^a	27.83 ± 0.22 ^a	72.18 ± 0.22 ^d	0.39 ± 0.03 ^a

Mean values having different superscript letters along the same column vary significantly ($p < 0.05$).

Table 4. Pasting properties of control, defatted, deproteinized, and defatted-deproteinized sorghum flour

Sample	Peak viscosity (RVU)	Trough viscosity (RVU)	Breakdown viscosity (RVU)	Final viscosity (RVU)	Set-back viscosity (RVU)	Peak time (min)	Pasting temp (°C)
Control	180.42 ± 0.23 ^a	108.46 ± 1.36 ^c	71.96 ± 1.12 ^a	218.67 ± 3.06 ^b	110.21 ± 1.71 ^b	4.73 ± 0.01 ^c	80.83 ± 0.04 ^c
Defatted	141.54 ± 2.53 ^b	116.80 ± 1.59 ^b	24.75 ± 0.95 ^b	250.46 ± 1.82 ^a	133.67 ± 0.23 ^a	4.80 ± 0.10 ^c	83.63 ± 0.53 ^b
Deproteinized	130.79 ± 0.76 ^c	120.83 ± 1.41 ^b	9.96 ± 2.18 ^c	204.46 ± 4.54 ^b	83.63 ± 5.95 ^c	5.74 ± 0.09 ^b	90.50 ± 0.07 ^a
Defatted-deproteinized	133.46 ± 3.95 ^c	128.04 ± 4.65 ^a	5.42 ± 0.71 ^d	215.33 ± 12.37 ^b	87.29 ± 7.72 ^c	9.00 ± 0.01 ^a	89.25 ± 1.77 ^a

Mean values having different superscript letters along the same column vary significantly ($p < 0.05$). RVU, rapid visco analyzer unit

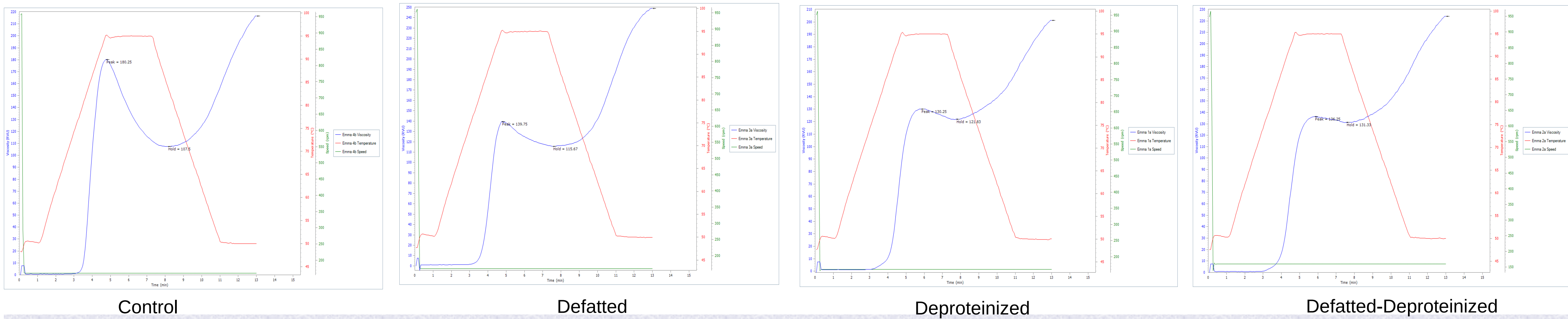


Figure 2. Representative amylographs of control, defatted, deproteinized, and defatted-deproteinized sorghum flour

CONCLUSIONS

The control sorghum flour contained the highest levels of the bioactive constituents and exhibited the most potent antioxidant activity. Defatting, deproteinization, and defatting and deproteinization led to a decrease in both the levels of the bioactive constituents and antioxidant activities of the flour, with defatting and deproteinization causing the highest decrease. In contrast, the defatted, deproteinized, and defatted-deproteinized flours had higher starch and amylose contents than the control. The control flour also had the highest peak and breakdown viscosities, and the least peak time and pasting temperature; while the defatted flour had the highest final and set-back viscosities. Therefore, endogenous lipids and proteins may enhance the antioxidant and pasting properties of sorghum flour; removing them from the flour is not recommended. These findings buttress the advantages of utilizing whole meal flours over refined flours, in the quest to end hunger, and achieve food security and improved nutrition.

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