Effect of protein extraction and fractionation of chia seeds grown in different locations: Nutritional, antinutritional and protein quality assessment

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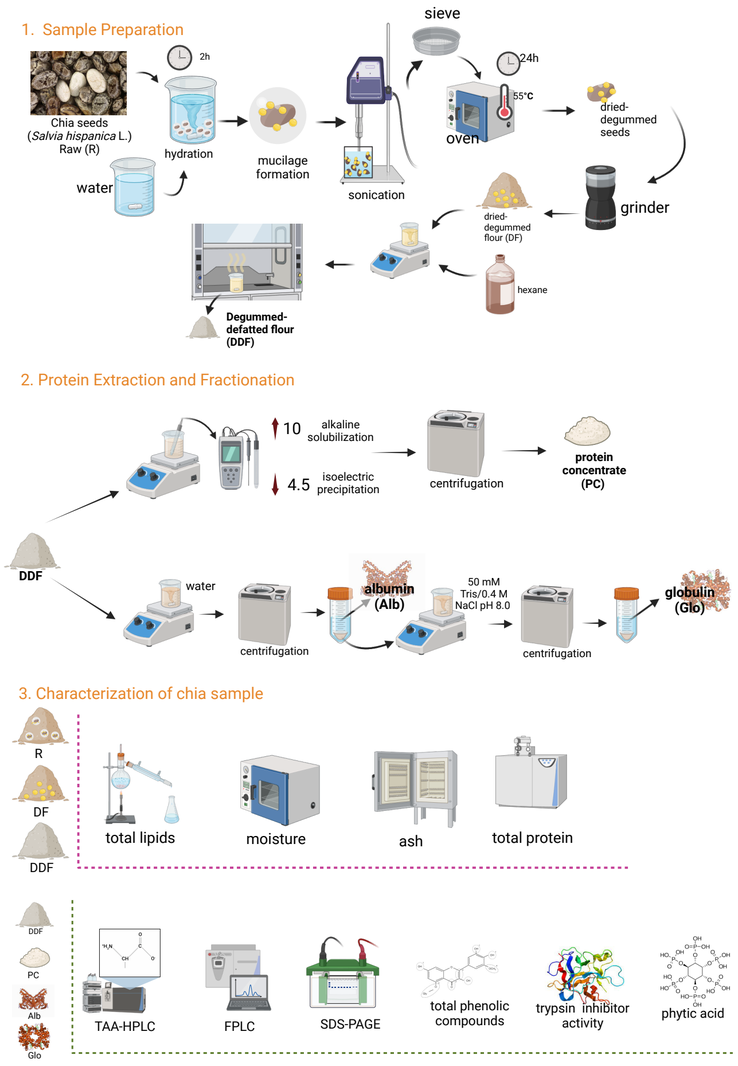
AIM

This study endeavors to evaluate the modifications produced by protein extraction and fractionation. The assessment spans the nutritional and antinutritional composition, protein profile, and protein quality of chia seeds cultivated in two distinct locations: Mexico and the UK. By undertaking this research, we aim to contribute to a more comprehensive understanding of the chia protein landscape, elucidating the influence of extraction and fractionation processes.

INTRODUCTION

With the increasing awareness regarding healthy diets and food sustainability in recent years, the concept of using protein-rich plant sources to replace animal proteins has become popular. Chia seeds (*Salvia hispanica* L.) have gained popularity due to their high protein content and nutritional benefits. However, traditional protein extraction methods, involving alkaline and acid treatment, may impact functional properties and nutritional quality.

METHODS



Abbreviations: DF, degummed chia flour; DDF, degummed-defatted chia flour; PC, protein concentrate; Alb, albumin fraction; Glo, globulin fraction, M, Mexican sample; B, British sample; AAS, amino acid score; EAAI, Essential amino acid index; BV, predicted biological value; PER, protein efficiency ratio; IVPD, *in vitro* protein digestibility; IVPDCAAS, IVPD-corrected amino acid score; TPC, total phenolic compounds; PA, phytic acids; TIA, trypsin inhibitor activity.

RESULTS

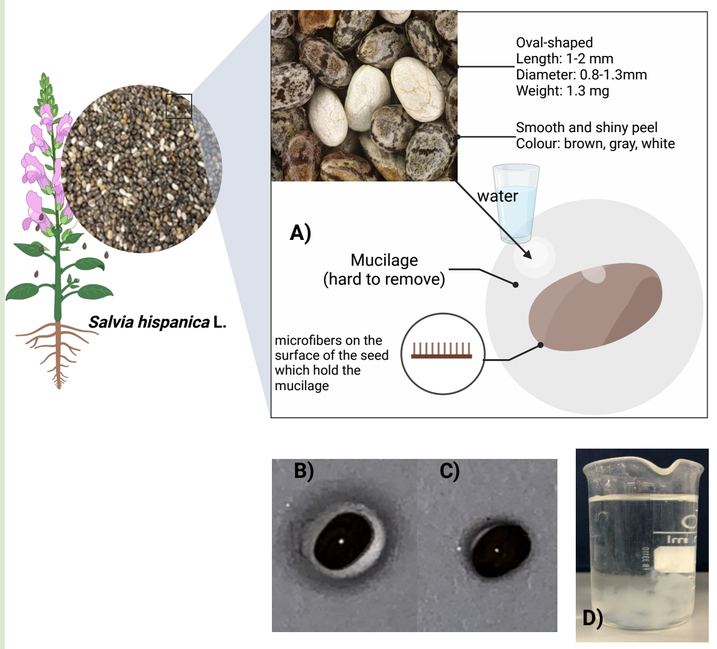


Figure 1. A) Chia mucilage; B) chia mucilage forms after hydration; C) degummed chia seeds; D) chia mucilage after ultrasound assisted extraction.

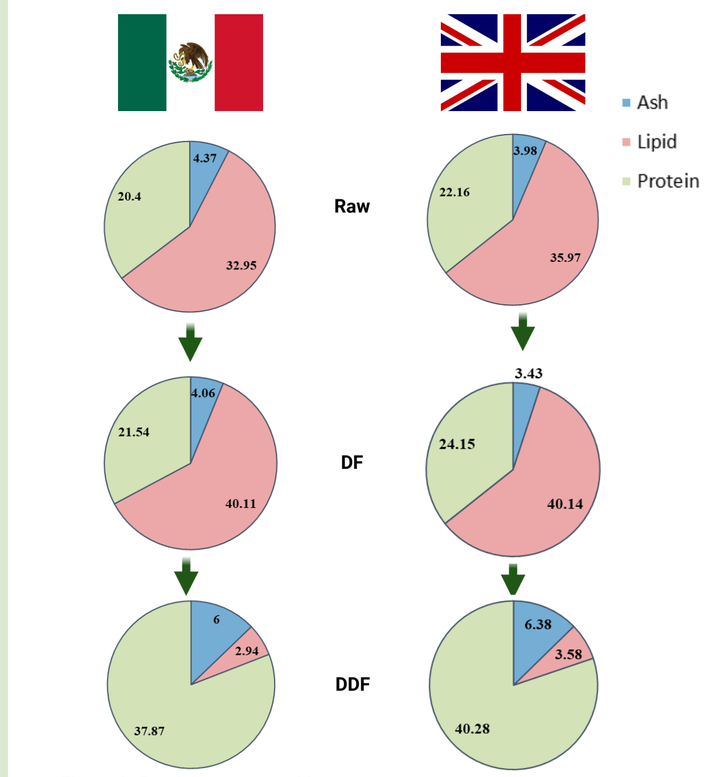


Figure 2. Proximate composition of raw, degummed, and degummed-defatted flours from Mexican and British chia samples (g/100g dw).

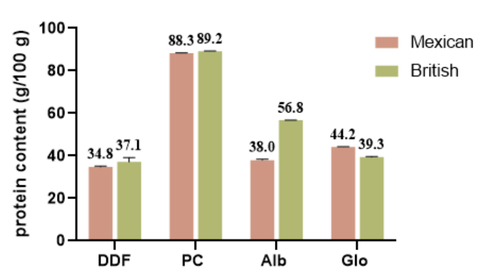


Figure 3. Protein content of chia protein ingredients from two locations.

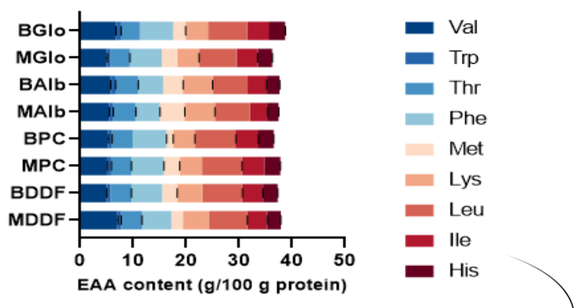


Figure 4. Comparison of essential amino acid contents of chia protein ingredients from two locations.

Table 1. Protein quality parameters of degummed-defatted flour, protein concentrates, and albumin and globulin fractions from Mexican and British chia samples.

Sample	Locations	AAS (%)	EAAI (%)	BV	PER_1	PER_2	PER_3	PER_4	PER_5	IVPD (%)	IVPDCAAS (%)
DDF	Mexican	133.72	310.52	326.77	2.4	2.55	2.83	2.68	3.04	78.03 ± 0.28^{c}	58.35
	British	131.03	325.36	342.94	2.5	2.66	3.35	2.62	3.03	81.65 ± 5.72^{b}	62.31
PC	Mexican	134.62	406.98	431.9	2.57	2.66	3.08	2.64	3.11	91.66 ± 0.84^{a}	68.09
	British	130.31	189.4	194.75	2.59	2.72	2.51	2.55	3.02	91.91 ± 0.65^{a}	70.53
Alb	Mexican	131.74	362.62	383.56	2.06	2.19	2.76	2.69	2.97	67.65 ± 0.51^{f}	51.35
	British	135.27	475.42	506.5	2.02	2.21	2.58	2.66	2.95	69.73 ± 0.13^{d}	51.55
Glo	Mexican	129.18	296.95	311.98	2.31	2.42	2.64	2.54	3.06	68.86 ± 0.38^{e}	53.31
	British	140.09	496.73	529.74	2.64	2.53	2.57	2.7	3.21	67.83 ± 0.95^{ef}	48.42

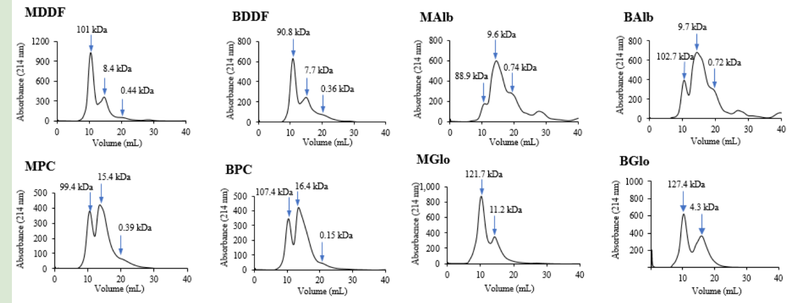


Figure 5. FPLC gel filtration analysis of chia samples.

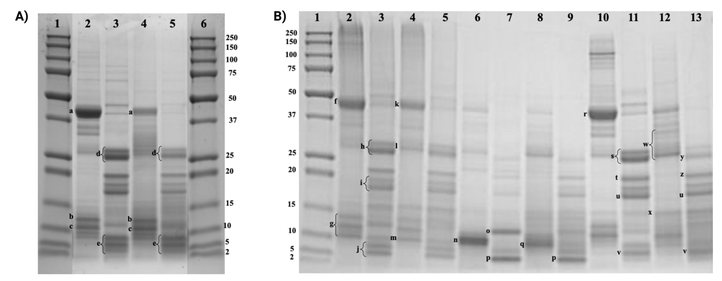


Figure 6. SDS-PAGE of protein samples from Mexican and British chia samples. **A)** SDS-PAGE of degummed-defatted chia samples. Lines: **1** and **6**) protein reference (kDa); **2**) Mexican chia-degummed-defatted (non-reducing); **3**) Mexican chia-degummed-defatted (reducing); **4**) British chia-degummed-defatted (non-reducing); **5**) British chia-degummed-defatted (reducing). **B)** SDS-PAGE of protein concentrates and fractions. Lines: **1**) protein reference (kDa); **2**) Mexican chia protein concentrates (non-reducing); **3**) Mexican chia protein concentrates (reducing); **4**) British chia protein concentrates (non-reducing); **5**) British chia protein concentrates (reducing); **6**) Mexican albumin fraction (non-reducing); **7**) Mexican albumin fraction (reducing); **8**) British albumin fraction (non-reducing); **9**) British albumin fraction (reducing); **10**) Mexican globulin fraction (non-reducing); **11**) Mexican globulin fraction (reducing); **12**) British globulin fraction (non-reducing); **13**) British globulin fraction (reducing). **a**, 45 kDa; **b**, 12 kDa; **c**, 10 kDa; **d**, 26.3–28.7 kDa; **e**, 3.7–8.1 kDa; **f**, 42.2 kDa; **g**, 10.5–15.0 kDa; **h**, 25.2–26.5 kDa; **i**, 16.9–17.5 kDa; **j**, 2.5–5.8 kDa; **k**, 43.3 kDa, **l**, 26.6 kDa; **m**, 7.7 kDa; **n**, 7.1 kDa; **o**, 10.1 kDa; **p**, 3.7 kDa; **q**, 6.3 kDa; **r**, 50 kDa; **s**, 25.9–28.2 kDa; **t**, 21 kDa; **u**, 18 kDa; **v**, 6 kDa; **w**, 26–30 kDa; **x**, 16 kDa; **y**, 28 kDa, **z**, 21 kDa.

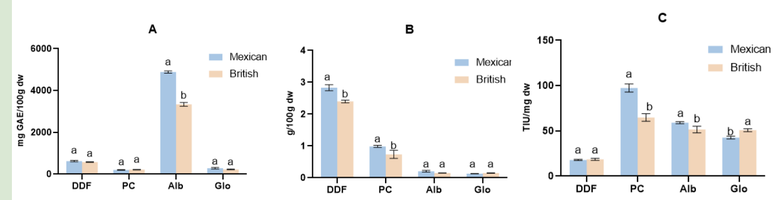


Figure 7. Antinutritional factors in chia DDF, PC, Alb, and Glo fractions. A: total soluble phenolic compounds (TPC, mg GAE/100 g dw); B: phytic acid (g/100 g dw); C: trypsin inhibitory activity (TIA, TIU/mg dw)

CONCLUSION

The study suggests that both Mexican and British chia protein fractions have potential as ingredients for developing food formulations with enhanced nutritional traits. The presence of antinutrients in chia samples indicates that protein digestibility could be reduced to some extent during gastrointestinal digestion due to the presence of certain antinutrients. These findings can aid in optimizing chia seed processing for improved functional properties and nutritional quality of protein ingredients.

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