Physical Properties of *Cucurbita Ficifolia* Seed and Functional Properties of Whole and Defatted Meal

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Abstract: The aim of this research was to describe some physical properties of *Cucurbita ficifolia* seeds and evaluate the effect of defatting on *C. ficifolia* seed meal functional properties. Geometric diameter was 8.05 mm, arithmetic diameter was 10.61 mm, sphericity was 45.36%, aspect ratio was 64.29%, surface area was 204.08 mm^2, volume was 187.44 mm^3, true density was 0.51 Kg/m^3, porosity was 31.81% and hardness was 6.23 N. Defatted *C. ficifolia* seed meal presented a content of protein (70.36 g/100 g) and carbohydrates (13.18 g/100 g). The defatted meal had higher water absorption capacity (2.94 g H_2O/g sample), water solubility capacity (34.08 %), oil absorption capacity (2.97 g oil /g sample), emulsifying capacity (24.93%), foaming capacity (30.33%) and better foam stability (from 20 to 60 min) than the whole meal. The high protein content of defatted seed meal, suggests its use as a natural alternative ingredient in numerous food industry applications.

Keywords: *Cucurbita ficifolia,* Functional properties, Linear dimensions, Chemical composition, Defatted meal.

1. INTRODUCTION

Pumpkin (*Cucurbita ficifolia*) is cultivated in Mexico for its edible fruit [1]. It is an annual monoecious plant, which is grown primarily in the states of Mexico, Hidalgo, Puebla and Veracruz. *C. ficifolia* is commonly known as “chilacayote”, and its immature fruit is used for preparing different dishes. The mature fruit of *C. ficifolia* is used to make a traditional Candy [1]. In the states of Mexico (3,587.60 tons), Morelos (528.20 tons) and Distrito Federal (68 tons), the annual production of *C. ficifolia* are 4,183.80 tons and the harvested area is 185 hectares [2]. Pumpkin seeds are an excellent source of protein (25.2-37%) and oil (37.8-45.4%) [3, 4]. Seed kernels have been used as an additive in some food dishes and several reports exist on the nutritional value of pumpkin seed kernel proteins and oils [4, 5]. Pumpkin seeds are usually a by-product from pumpkin pulp processing at either artisanal or large scale. It is estimated that seeds constitute 2.9% in weight of fresh fruit, while in dry basis accounted for 32%. Global demand for new protein sources has focused mainly on oilseeds and their agro-industrial by-products, defatted oil meals. Their protein content makes pumpkin seeds a promising raw material in the production of high-quality protein products for use as nutritional supplements or functional agents in food formulations, the main proteins in pumpkin seed consist of storage salt-soluble globulins (cucurbitin), as well as albumins, glutelins and prolamins [6-8]. However, no studies have been published on *C. ficifolia* seed physical (linear and geometric) properties or the functional properties of *C. ficifolia* seed meal. The usefulness of seed flours in food would depend on their protein functionality. Important protein-based functional properties include protein solubility, water and oil absorption, emulsion capacity, foaming capacity, viscosity and gelation. Functional properties of proteins, in general, are affected by various intrinsic and extrinsic factors. Protein molecular structure and size are important intrinsic factors, whereas extrinsic factors include the method of protein extraction, pH, ionic strength, the components in the food system [9-10] and processing conditions. Functional and

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physicochemical properties depend on seed place of origin, weather and harvest conditions. Physical properties of seeds are necessary for the design of equipment to handle, transport, process and store the crop. Several varieties of pumpkin are grown in Mexico, but as far as we know, no published studies address the chemical composition, physical or functional properties of any of these varieties. Therefore, the aim of this research was to describe some physical properties of *Cucurbita ficifolia* seeds as well as evaluate the effect of defatting *Cucurbita ficifolia* seed meal on chemical and functional properties.

2. MATERIALS AND METHODS

Pumpkins (*Cucurbita ficifolia*) were acquired from a local market in the community of Pachuca, Hidalgo State, Mexico. Ripe pumpkins were cut open, and the seeds were removed. Seeds were manually dehulled and cleaned and those with no physical damage were selected.

2.1. Physical Properties

2.1.1. Linear Dimensions

Seed linear dimensions (Figure **1**) were measured according to Mpotokwane *et al* [11]. One hundred (100) seeds were selected from a handful taken randomly from a container full of seeds. Using a Vernier caliper, length (L), width (W) and thickness (T) of each selected seed were measured to an accuracy of 0.001 mm. These data were then used to calculate geometric diameter, sphericity, arithmetic diameter, equivalent diameter, volume, surface area and aspect ratio.

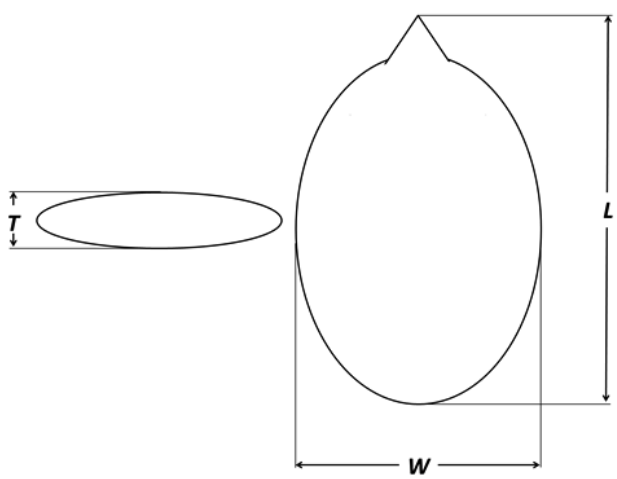

Figure 1: Linear measurement of *Cucurbita ficifolia* seeds, where, *L*: length: *W*: width; *T*: thickness.

Geometric Diameter, Arithmetic Diameter, Sphericity, Volume, Surface Area and Aspect Ratio

Seed geometric diameter (D_g), arithmetic diameter (D_a), and sphericity (**Ø**) were calculated using the equations [12]:

$$D_g = (L\,W\,T)^{1/3} \quad (1)$$

$$D_a = \frac{(L+W+T)}{3} \quad (2)$$

$$Ø = \frac{(L\,W\,T)^{1/3}}{L}\,x\,100 \quad (3)$$

Where *L* = seed length, *W* = seed width and *T* = seed thickness in mm. Volume (V) and Surface area (S in mm^2) were calculated with the equations [13], diameter of the spherical part of the seed, mm (B):

$$S = \frac{\pi B L^2}{(2L-B)} \quad (4)$$

$$V = \frac{\pi B^2 L^2}{6(2L-B)} \quad (5)$$

$$B = (WT)^{0.5} \quad (5.1)$$

Seed shape was further described via the aspect ratio (AR) [14]:

$$AR = \frac{W}{L}\,x\,100 \quad (6)$$

2.1.2. Thousand-Seed Weight

Thousand-seed weight (TSW) was measured according to Mpotokwane *et al* [11]. The mass of one thousand seeds was measured with an electronic balance (accuracy = 0.0001 g) in triplicate.

2.1.3. Bulk and True Density and Porosity

The bulk density is the ratio of the mass of the sample to its container volume. It was measured by weighing a filled measuring cylinder with known volume and calculated as:

$$\rho_b = \frac{m}{V} \quad (7)$$

Where ρ_b, bulk density (kg/m^3), m is mass (kg) of the sample. The true density is defined as the ratio of mass of the sample to its true volume [9].

$$\rho_t = \frac{m}{n * V_u} \quad (8)$$

$$V_u = \frac{4}{3}\pi * {(L * W * T)}/{1000} \quad (8.1)$$

Where ρ_t, true density (kg m^{-3}), n is number of kernels in the sample. Unit volume, Vu (cm^3), of kernels was determined based on the assumption that kernels are similar to a scalene ellipsoid where L > W > T [12]. Porosity, ε (%), indicates the amount of pores in the bulk material and it was calculated as [12]:

$$\varepsilon = \left(1 - \frac{\rho_b}{\rho_t}\right) x\ 100 \quad (9)$$

2.1.4. Hardness

The hardness of seeds was determined by measuring the maximum force required to break the seed samples using a Stable Micro system TA-XT2 texture analyzer (Stable Micro Systems, Ltd., Surrey, UK). The results were expressed in newtons (N).

2.1.5. Raw Material Preparation

Seeds were manually dehulled with a nutcracker, and undamaged seeds were selected for further processing. These were ground in a coffee grinder (Krupps Model GX4100) until the particles could pass through a No. 30 mesh screen (0.59 mm, U.S.A. standard test sieve ASTM E-11 Specification W.S. Tyler, USA). The resulting meal was placed in sealed polyethylene bags and stored at 4 ± 0.5 °C until use.

2.1.6. Meal Defatting

The seed meal was defatted according to standard AOAC methods [15]. Lipid (Method 948.22). Defatted samples were dried at 50 °C (ED 115 Binder Oven) overnight (~10- 12 h). They were screened through No. 30 (0.59 mm, U.S.A. standard test sieve ASTM E-11 Specification W.S. Tyler, USA) mesh, and then stored at 4 ± 0.5 °C.

a. Chemical Composition

Proximate composition of the whole and defatted *C. ficifolia* seed meals (WFSM and DFSM, respectively) was determined in triplicate according to standard AOAC methods [15]: moisture (925.10); ash (942.05); protein (960.52); and fat (948.22). Crude fiber was determined by acid-alkaline digestion [16], and carbohydrates by difference. Gross energy was calculated following the methodology described by Ekanayake *et al* [17].

2.3. Functional Properties

2.3.1. Water Absorption Capacity (WAC) and Water Solubility Capacity (WSC)

Water absorption capacity (WAC) and water solubility capacity (WSC) were determined according to Anderson *et al* [18].

2.3.2. Oil Absorption Capacity (OAC) and Emulsification Capacity (EC)

Oil absorption capacity (OAC) was measured according to Beuchat [19]. The OAC was expressed as grams of retained oil per gram of sample. Emulsification capacity was determined according to Yasumatsu *et al*. [20].

2.3.3. Foaming Capacity and Foam Stability

Foaming capacity (FC) and foam stability (FS) were also determined on WFSM and DFSM. Foaming capacity was measured according to Coffman & García [21]. The results were expressed as percentage of increase in volume. Foam volumes were recorded at 10, 15, 30, 45 and 60 min intervals to study the FS of the samples [22].

2.3.4. Bulk Density (BD)

Flour samples were evaluated and bulk density was determined as described by Joshi *et al* [23]. Bulk density was calculated as mass of sample per unit volume of sample (g/cm^3).

2.4. Statistical Analyses

Results were analyzed with a one-way analysis of variance (ANOVA) and differences between the means calculated using a least significant difference test with a 95% confidence level. All analyses were done with the Statistica ver. 8.0 program StatSoft, Inc.

3. RESULTS AND DISCUSSION

3.1. Physical Properties

Table **1** shows the physical properties of *Cucurbita ficifolia* seeds. The comparison of *Cucurbita ficifolia* seed physical properties (L, W, T, D_g Ø and AR) to other seeds as Ebony seed, Lentil seeds, Carob beans, *Canavalia cathartica* seed, Castor seeds, Pistachio kernel, *Parkia speciosa* seeds, Pistachio, Gruondnut, and Cucurbit seeds were presented in the Table **2**. The value for true density was of 0.51 kg/m^3 and the bulk density of 0.50 kg/m^3. Density characteristics are quite useful in determining space requirements for design of grain hoppers, grain storage facilities and grain-conveying systems [34]. Porosity is an important data necessary to design the aeration systems during storage. Higher the porosity, better the aeration and water vapour diffusion during deep-bed drying [35]. Seed porosity is the most important attribute for packing. It also affects resistance to airflow through bulk seeds [36]. The porosity found in pumpkin seeds

Table 1: Physical Properties of *Cucurbita Ficifolia* Seeds

Physical Properties	Unit	N	Mean Value	Range of Values	Standard Deviation
Length (L)	mm	100	17.88	10.04 - 20.06	1.55
Width (W)	mm	100	11.34	10.22 -17.02	0.76
Thickness(T)	mm	100	2.59	2.13 - 2.88	0.15
Geometric diameter (D_g)	mm	100	8.05	6.40 - 8.64	0.33
Arithmetic diameter (D_a)	mm	100	10.61	7.66 - 11.54	0.50
Sphericity (Ø)	%	100	45.36	40.15 - 70.92	4.26
Aspect ratio (AR)	%	100	64.29	54.53 - 149.69	11.44
Mass	kg	15	0.17	0.16 - 0.18	0.05
Surface area (S)	mm^2	100	204.08	128.76 - 234.46	16.21
Volume (V)	mm^3	100	187.44	136.84 - 524.78	41.10
True density (ρt)	Kg/m^3	15	0.515	0.508 - 0.530	0.01
Bulk density (ρ_b)	Kg/m^3	15	0.50	0.47 - 0.53	0.03
Porosity (ε)	%	15	31.81	29.74 - 35.45	1.68
Hardness (H)	N	30	6.23	4.53 - 8.42	1.08

(31.81%) is lower than reported for other seeds as *Jatropha curcas* seed (34.6 - 43.3%), basil seed (*Ocimum basilicum*) (67.20%), *Canavalia cathartica* seed (44.57%), red clover seeds (*Trifolium pratense* L.) (32.7%), and porosity of cucurbit seeds ranged from 39 to 55%, and was higher than the one of flax seeds (*Linum usitatissimum*) (16.83%) [27, 33, 36-39]. Hardness is a key factor in the pressing process [37]. Hardness (6.23N) was smaller than that of basil seed (*Ocimum basilicum*) (9.08 N), Pistachio nut (*Pistacia vera* L.) (13.39-14.64 N), and sorghum kernels (*Sorghum bilcolour* (L) Moench) (50-90 N) [29, 39, 40]. The correlation coefficients obtained between the main dimensions and mass are given in Table **3**. Width and geometric mean diameter were positively and significantly correlated ($P < 0.01$) with length. However, length and thickness of the *Cucurbita ficifolia* seeds were not significantly correlated with mass. In Table **3**, the correlation coefficients of the linear dimensions of seed showed that L/W ratio is lower than L/T and L/M ratios; meaning that the thickness of the seed is closely related to its length, while the length and mass have a higher association.

3.2. Chemical Properties

The WFSM and DFSM differed ($P < 0.05$) in all the measured chemical parameters (Table **4**). This effect of defatting on the different chemical parameters coincides with that reported in other studies [4, 10, 41]. Energy content in the DFSM (1,395.01 kJ/100 g DM) was lower than in the WFSM (2,556.63 kJ/100 g d.b.), probably due to defatting since lipids provide more energy per gram than proteins and carbohydrates combined [41]. Protein content in WFSM was of 35.25 g/100 g, these data are higher than the reported for other selected seeds [23], but below the one reported for seeds *Cucurbita pepo* (35.45 g /100 g) [4] and ebony (38.51 g /100 g) [21]. Lipids content in the WFSM was lower than in macadamia (67.63 g/100 g) [23] and higher than in jack bean (3.1 - 6.0 g/100 g) [42], cowpea (2.77 g/100 g) [43], soybean (21.88 g/100 g) [23], ebony (28.16 g /100 g) [24], seinat (*Cucumis melo var. tibish*) (31.13 g /100 g) [44], and *Cucurbita pepo* (49.14 g/100 g) [4]. Although the crude fat content of the flour was low, it could be useful in improving palatability of foods in which it is incorporated [24]. Crude fiber content in the WFSM was much lower than reported for other seeds. The high ash content indicates that it could be an important source of minerals for consumers. Carbohydrate content in the WFSM was lower than in jack bean (50.77 - 54.28 g/100 g) [42], cowpea (56.49 g/100 g) [43], ebony (29.36 g /100 g) [24] and *Cucurbita pepo* (7.85 g/100 g) [4]. In the DFSM, protein content (Table **4**) was higher than in other defatted seeds [24, 41, 44-47]. According to Bressani [47], higher level of protein content of seed materials has nutritional significance, since a moderate intake of these seeds will greatly increase the total dietary protein intake of consumers. Its utilization as a protein ingredient in the animal feeds will reduce the over-dependence on the conventional protein supplements, such as soybean and other common legumes [24]. The DFSM's protein content makes it a

Table 2: Comparison of *Cucurbita Ficifolia* Seed Physical Properties with other Seeds

Property	*C. Ficifolia*[a]	Ebony Seed [24]	Lentil Seeds [25]	Carob Beans [26]	*Canavalia Cathartica* seed [27]	Castor Seeds [28]	Pistachio Kernel [29]	*Parkia Speciosa* Seeds [30]	Pistachio [31]	Gruond nut [32]	Cucurbit Seeds [33]
L (mm)	17.88	13.02	4.07-4.13	7.74-9.49	16.62	13.52	15.60-16.25	23.20	13.98	20.83	17.54-23.74
W (mm)	11.34	8.78	3.93-3.99	5.49-7.34	10.66	13.39	9.11-10.40	17.27	8.76	11.08	6.88-13.64
T (mm)	2.59	9.65	2.32-2.38	3.70-4.05	8.94	13.38	8.96-9.76	9.87	7.25	8.94	3.12-4.67
D_g (mm)	8.05	10.76	3.23-3.39	5.38-6.54	11.64	13.42	10.81-11.78	15.80	9.75	12.71	7.09-11.48
Ø (%)	45.36	83.26	81.85-82.16	69-70	70	99.41	69.10-72.50	68.15	69.34	61.12	40-48
AR (%)	64.29	68.24	-	71.31-77.50	-	99.31	-	74.51	-	-	-
S (mm^2)	204.08	364.33	34.84-36.15	77.36-113.9	428.82	566.62	366.31-436.24	786.86	289	-	158-413

Notes: [a] This research. Other research [24 - 33]

Table 3: Ratios and Coefficient of Correlation (r) Values of *Cucurbita Ficifolia* Seed Dimensions

Particulars	Mean Value	Range of Values	Standard Deviation	r
L/W	1.58	0.67 - 1.83	0.17	-0.34**
L/T	6.93	3.73 - 8.62	0.72	0.05
L/M	10.55	5.81 - 11.80	0.94	0.00
W/M	6.69	5.86 - 9.94	0.45	0.19
T/M	1.53	1.27 - 1.68	0.09	0.16
L/D_a	1.68	1.10 - 1.79	0.10	0.86**

Notes: ** Significant difference ($P < 0.01$). L = Length; W = Windth; T = Thickness; M = mass; D_a = Arithmetic diameter.

potential ingredient for increasing the nutritional value of new food products.

Table 4: Chemical Properties (Dry Basis) of Whole *C. Ficifolia* Seed Meal and Defatted *C. Ficifolia* Seed Meal

Component (g/100 g)	WFSM	DFSM
Protein (N x 6.25)	35.25 ± 0.21[a]	70.36 ± 0.64[b]
Fat	49.89 ± 1.81[a]	0.00 ± 0.00[b]
Crude fibre	3.74 ± 0.16[a]	4.67 ± 0.0.58[b]
Ash	5.91 ± 0.0.26[a]	11.80 ± 0.10[b]
Carbohydrates[1]	5.20 ± 0.57[a]	13.18 ± 0.06[b]
Gross energy (kJ/100 g DM)	2556.63 ± 41.08[a]	1395.01 ± 9.79[b]

Notes: Means ± standard deviation. Different letter superscripts in the same row indicate significant difference ($P < 0.05$). DM = Dry matter. [1]Obtained by difference. WFSM = whole *C. ficifolia* seed meal. DFSM = defatted *C. ficifolia* seed meal.

3.3. Functional Properties

The WFSM and DFSM differed ($P < 0.05$) in all the six evaluated functional parameters (Table **5**). Water absorption capacity (WAC) was higher ($P < 0.05$) in the DFSM (2.94 g H_2O/g sample) than in the WFSM (1.40 g H_2O/g sample), probably in response to the higher availability of polar amino acids and lower fat content in the DFSM. WAC is related to the hydrophilicity and gelation capacity of biomacromolecules, such as starch and protein, in flour [48]. Some studies indicate that WAC increases with defatting, since it promotes protein-water interactions, which in turn depends on the number and type of hydration sites, the physicochemical environment (pH, solutes, protein arrangement, temperature, solvents, surfactants, carbohydrates, lipids, etc.) and system thermodynamic properties [4, 23]. The DFSM WAC value was slightly higher than the 2.48 g water per g meal reported for a mixture of DFSM (*C. pepo* and *C. maxima*) [49], but below that reported for *C. pepo* water per g meal [4].

Table 5: Functional Properties of Whole C. Ficifolia Seed Meal and Defatted Determined at 25 °C

Functional Properties	WFSM	DFSM
Water absorption capacity - WAC(g H_2O/g sample)	1.40 ± 0.02[a]	2.94 ± 0.24[b]
Water solubility capacity - WSC (%)	10.09 ± 0.16[a]	34.08 ± 0.57[b]
Oil absorption capacity - OAC(g oil/g sample)	1.54 ± 0.03[a]	2.97 ± 0.06[b]
Emulsification capacity- EC (%)	22.00 ± 0.06[a]	24.93 ± 0.22[b]
Foaming capacity - FC (%)	19.17 ± 0.76[a]	30.33 ± 1.53[b]
Bulk density- BD (g/cm^3)	0.50 ± 0.01[a]	0.31 ± 0.01[b]

Notes: Values represent the average of three replicates ± standard deviation. Different letter superscripts in the same row indicate significant difference ($p < 0.05$). WFSM = Whole *C. ficifolia* seed meal; DFSM = Defatted *C. ficifolia* seed meal

Water solubility capacity (WSC) (Table **5**) was higher ($P < 0.05$) in the DFSM (34.08 %), probably due to the presence of a greater quantity of water-soluble proteins. Protein solubility is the most important physicochemical and functional property because it influences other properties directly affected by protein concentration and solubility, such as foaming capacity, emulsifying capacity and gel formation [50]. The DFSM value was higher than the reported for *C. pepo* seed [4].

Oil absorption capacity (OAC) is an important property in food formulations because oils improve the flavor and mouth feel of foods [51]. The OAC (Table **5**) was also higher ($P < 0.05$) in the DFSM (2.97 g oil/g sample) than in the WFSM (1.54 g oil/g sample). This was probably due to the exposure of a greater number of nonpolar sites of the proteins present in the defatted sample that can be bound to hydrocarbon oil units, resulting in greater OAC. Oilseeds, with their high OAC, may be better suited flours for confectionery applications requiring oil emulsification [23].

Emulsifying capacity (EC) was also higher ($P < 0.05$) in the DFSM (Table **5**). The emulsion activity reflects the ability and capacity of a protein to aid in the formation of an emulsion and it is related to the protein's ability to absorb to the interfacial area of oil and water in an emulsion [48]. The emulsion stability normally reflects the ability of the proteins to impart strength to an emulsion for resistance to stress and changes, and it is therefore related to the consistency of the interfacial area over a defined time period [52]. This may be due to the increase in protein hydrophobic groups after defatting, which increases surface adsorption forming a cohesive interphase film between the oil and water [53]. The DFSM EC values were higher than reported for other legume meals [53]. Its higher EC highlights the DFSM's potential applications in milk substitutes and meat analogues, or any product requiring good emulsion formation, such as sauces, creams and fat analogues, among others.

Foaming capacity (FC) was higher ($P < 0.05$) in the DFSM than in the WFSM. Defatting increased the FC of the DFSM because this property is directly linked to protein concentration, structure and solubility. FC and stability generally depend on the interfacial film formed by proteins, which maintains the air bubbles in suspension and slows down the rate of coalescence [48]. Foaming properties are dependent on the proteins and some other components, such as carbohydrates, that are present in the flours [54]. Foam stability (FS) is the decrease in foam volume over time. This parameter was higher ($P < 0.05$) in the DFSM than in WFSM at all evaluated times (Figure **2**). In WFSM, FS dropped by half at 20 min. With the WFSP, FS dropped to 21% at 20 min. In both meals, FS remained stable from 45 to 60 min.

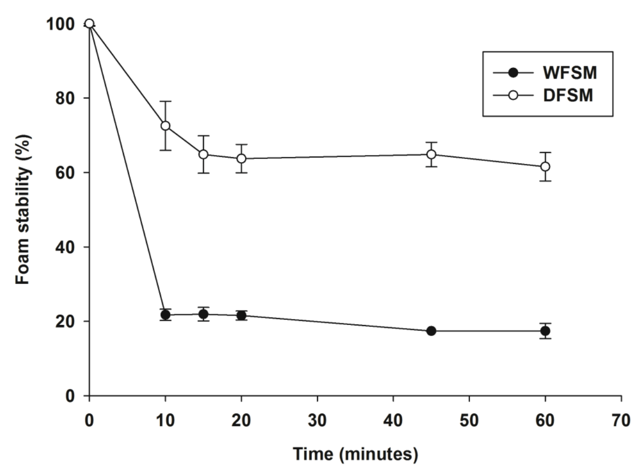

Figure 2: Foam stability of whole *C. ficifolia* seed meal (WFSM) and defatted *C. ficifolia* seed meal (DFSM) at different time. Three replicates were taken for data analysis.

The bulk density (BD) is generally affected by the particle size and it is very important in the determination of a packaging or packaging system, and in material handling [55]. Bulk density (BD) is highly dependent on particle size, which was why the WFSM (0.50 g/cm^3) had a higher ($P < 0.05$) BD than the

DFSM (0.31 g/cm^3) (Table **5**). The values obtained are below those reported for Kabuli chickpea meal 0.571 g/cm^3 [56], ebony seed meal 0.85 g/cm^3 [24], and pumpkin seed meal 0.57 g/cm^3 [4]. Joshi [23] has reported a decreased bulk density in the defatted seed flours.

Least Gelation Concentration (LGC) was 14% (w/v) with the WFSM and 8% with the DFSM. LGCs of the full fat and defatted flours are comparable with the LGCs of pumpkin seeds flour [4], ebony seed flour [24], wheat flour [57] and Chickpea, Peanut, Sesame, and Hazelnut meals [23]. This difference may be related to the relative protein, carbohydrates and lipids quantities in each meal. Defatting produced higher protein and carbohydrate contents in the DFSM, explaining why a lower concentration of this meal was needed for gel formation. Protein concentration is vital to gel formation and firmness, and a greater proportion of globular proteins helps to improve this process [24]. Higher protein concentration improves gel firmness. Protein denaturation and starch gelling can also influence gelling properties [41]. A decrease in LGC, upon defatting, may help gel formation in the development of low fat high protein products [23]. The fact that the DFSM formed gels at low concentrations suggests its use in formulating cheese substitutes, or as an additive to promote gel formation in food products.

CONCLUSIONS

Cucurbita ficifolia seed average dimensions were 17.88 mm length, 11.34 mm width and 2.59 mm thickness. Geometric diameter was 8.05 mm, Arithmetic diameter was 10.61 mm, sphericity was 45.36%, aspect ratio was 64.29%, surface area was 204.083 mm^2, volume was 187.44 mm^3, true density was 0.51 Kg/m^3, porosity was 31.81% and hardness was 6.23 N. Thousand-seed weight was 0.22 Kg, of which 0.17 Kg (74.90%) represented the kernel. These data can be used to design post-harvest processing equipment and seed quality control measures. Defatting of the seeds increased protein and carbohydrates proportions, consequently improving functional properties. Defatted *C. ficifolia* seed meal could have potential applications in compound flour formulations, as a principal ingredient in bread and pastry products, or as a natural additive in new product formulations.

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