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Effects of soaking time and freezing on the gel strength of Moi-Moi prepared from Cowpea (*Vigna unguiculata*) grains

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ABSTRACT. Moi-Moi is traditionally made using cowpea (*Vigna unguiculata*). It is a vital staple food in West Africa due to its palatability and high protein content. The research determined the effect of freezing and soaking time on the gel strength of Moi-Moi prepared from cowpea. The cowpea varieties were sorted, cleaned, and portioned into two. A portion of each variety was frozen for one week, while the remaining portions were not. Cowpeas were soaked in water for 1 h, 2 h, and 3 h before being dehulled, oven-dried, and dry-milled with an attrition mill to obtain cowpea flour. Results showed that the gel strength (as penetration rate) of the samples from wet-milled cowpea grains ranged from 127.34 – 173.70 g/mm^2, 143.87 - 194.00 g/mm^2, and 165.37 – 243.93 g/mm^2 for 1 h, 2 h, and 3 h soaking times, respectively. Samples with higher values of penetration (g/mm^2) have much more tenderness and lower gel strength. The gel strength of samples AF, ANF, BNF, CF, and CNF were significantly ($P>0.05$) the same but differed significantly ($P<0.05$) amongst others at 1 h soaking time. At 2 h soaking, the gel strength results for samples AF, ANF, and BF were considerably identical ($P>0.05$). The gel strength results of most samples differ significantly ($P<0.05$) after 3 h of soaking, while those of CF and CF are significantly the same ($P>0.05$). The gel strength (penetration rate) of Moi-Moi prepared from dry-milled cowpea ranged from 169.73 - 242.60 g/mm^2, 191.73 - 294.03 g/mm^2, and 210.97 - 344.97 g/mm^2 for 1 h, 2 h, and 3 h respectively. Moi-Moi prepared from cowpea grains soaked for 1 h had the highest gel strength, followed by those of 2 h. Samples prepared from dry-milled cowpea soaked for 2 h had the least gel strength. Moi-Moi samples made with unfrozen cowpea grains possessed a greater gel strength than those made with frozen cowpea grains. The research provides sufficient information for literature review in further studies on the gel strength of Moi-Moi, as sufficient work has not been done on this aspect.

Keywords: Cowpea paste; dry-milled Cowpea grain; penetration rate; soaking time; wet milling

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INTRODUCTION

Cowpea is among the main vital legumes for forage and food in semi-arid tropics including Southern Europe, Africa, Asia, South and Central America, and Southern US (Singh 2005; Timko et al., 2007). Some cowpeas are harvested fresh, while the seeds have high moisture content. It is often cooked with water and stored in cans or kept frozen for consumption and or processing into other food products such as Moi-Moi. The utilization of cowpea and its products are adversely influenced by postharvest losses. To check the spoilage or postharvest loss, one or a combination of several preservation techniques such as freezing can be employed to preserve cowpea. Cowpeas can be frozen to achieve this purpose. Frozen storage refers to storage at temperature where the food is frozen, usually at temperature of -18°C or below. The extended shelf-life of frozen or chilled foods is due to both a reduction in the chemical changes as well as arrest of microbial growth (Uzuegbu & Eke, 2000). Safety freezing and frozen storage of food tends to result in degradation of quality of the food materials (Feng et al., 2020). Some of these quality characteristics include functional properties, gel

strength and sensory attributes. Other processing techniques involved in processing cowpea grains into other indigenous consumable food products (such as Moi-Moi and Akara) affect the quality characteristics of the products.

Moi-Moi, a steamed paste made from cowpea flour, is common in West African Countries, especially in Nigeria (Ngoddy et al., 2000). Moi-moi is traditionally made using cowpea variety Vigna unguiculate. It is vital staple food in West Africa due to its palatability and high protein content. Moi-moi can either be prepared from cowpea flour (processed by dry-milling) or cowpea paste (processed by wet-milling). In either way, the cowpea grains are soaked to optimize dehulling of the grains. Soaking time significantly influences the quantity (volume) of water taken up by the food material and this invariably plays crucial roles in the shelf life (moisture content), functionality and quality characteristics (sensory attributes and gel-strength) of the final food products (Chinaza et al., 2020; Hannington et al., 2020).

This research work aims to comparatively investigate how freezing (a preservation technique) and soaking time (a processing technique) affect the gel-strength of an indigenous staple food (Moi-Moi) prepared from six selected cowpea varieties as little or no research work has been done on this. The research work would also serve as a literature review and guide for researchers and food processors respectively.

MATERIALS AND METHODS

Six different varieties of cowpea of known identities were obtained from a scientifically confirmed source and other raw food materials for the Moi-Moi preparation were obtained from Ekeonunwa market in Owerri, Imo state. The equipment and other materials for analysis were obtained from Department of Food Science and Technology and Imo Agricultural Development Programme (Imo-ADP) headquarters.

Preparation of samples. For flour samples (Fig. 1), each of the cowpea varieties were sorted, cleaned and portioned into two. A portion of each of the varieties was frozen for one week while the others were kept non-frozen. They were soaked (a different time intervals; 1 hour, 2 hours and 3 hours) in water, dehulled, oven-dried and dry-milled using attrition milling machine to obtain the cowpea flour samples for paste samples (Fig. 2), each of the cowpea varieties were sorted, cleaned and portioned into two. A portion of each of the varieties was also frozen for one week while the others were kept non-frozen. They were also soaked (a different time intervals; 1 hour, 2 hours and 3 hours) in water, dehulled, and wet-milled using attrition milling machine to obtain the cowpea paste samples.

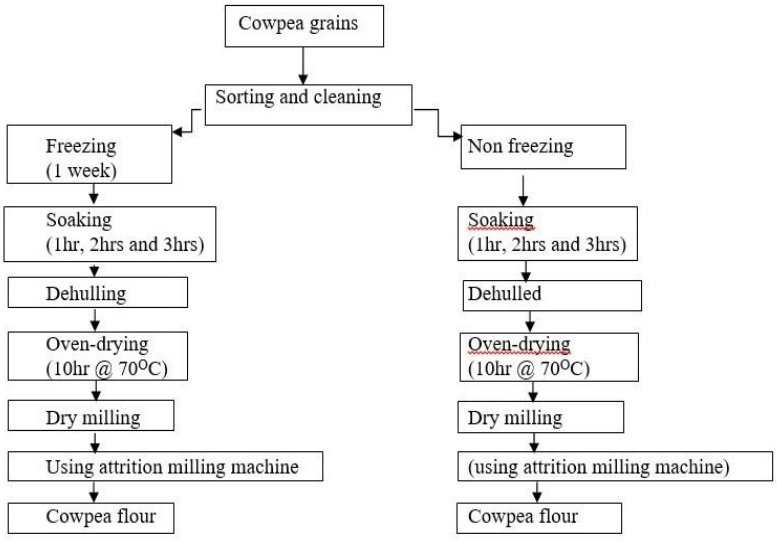

Fig. 1. Flow chart of the flour samples processing from cowpea grains.

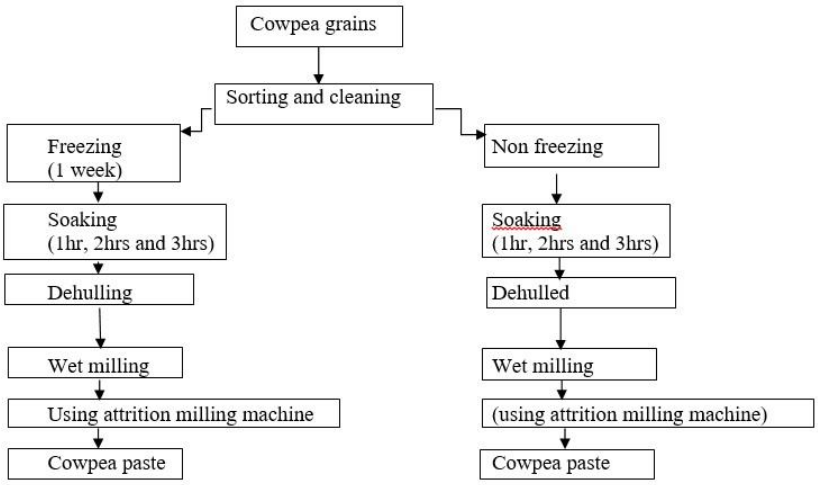

Fig. 2. Flow chart of the paste samples processing from cowpea grains.

Preparation of sample products (moi-moi) from the cowpea flours. Fresh pastes were prepared from the different cowpea flours. The flour samples and the paste samples were reconstituted with 150 ml volume of water. Paste samples were mixed thoroughly using HM 430 (Selangor, Malaysia) blender for 5 minutes. After which other ingredients were added; mixing was maintained for 2 minutes. As recommended by Ogundele et al., 2015, "50g of the paste was scooped into the aluminum foil, wrapped and steam cooked for about 40 min." The samples were left to cool.

Determination of gel strength of the oi-moi samples. To determine the gel strength, the moi-moi samples were prepared in a cylindrical container, allowed to cool at room temperature overnight after wrapping the moi-moi using aluminum foil. The gel strength was measured as gram per millimeter square according to the procedure of Marinho-Soriano & Bourret (2003) modified by Kumar & Fotedar (2009).

Statistical Analysis of Data. All experiments were carried out in triplicate. Mean and SD were determined. Data were subjected to ANOVA. The means were separated by Fischer's least significant difference (Minitab 16). Significant level was accepted at 5%.

RESULTS AND DISCUSSION

Gel strength of Moi-Moi samples prepared from wet-milled cowpea grains illustrated in Table 1.

Table 1. Gel strength of Moi-Moi samples prepared from wet-milled cowpea grains soaked at different time intervals.

Samples	Gel strength (penetration rate) of moi-moi at different soaking time (g/mm^2)		
	1hr	2hrs	3hrs
A_F	173.70a ± 1.04	194.00a ± 12.12	243.93a ± 5.48
A_{NF}	172.10a ± 1.91	197.70a ± 2.25	216.43b ± 5.14
B_F	169.03b ± 1.44	193.63a ± 1.10	210.23c ± 0.98
B_{NF}	172.20a ± 2.25	187.00b ± 0.00	200.13d ± 0.46
C_F	171.77a ± 1.96	185.70b ± 1.21	196.80de ± 0.87
C_{NF}	174.17a ± 1.33	183.07b ± 0.29	195.00e ± 1.04
D_F	142.13c ± 0.98	164.17c ± 0.92	189.17f ± 0.81
D_{NF}	132.67e ± 1.44	160.34cd ± 1.67	179.40g ± 1.39
E_F	130.43e ± 0.98	155.97de ± 1.67	176.90g ± 1.91
E_{NF}	135.57d ± 0.98	152.30ef ± 2.42	171.97h ± 0.06
F_F	123.27g ± 1.10	149.50fg ± 0.52	168.97hi ± 0.12
F_{NF}	127.34f ± 1.10	143.87g ± 1.44	165.37i ± 150
LSD	1.439	3.759	2.380

Notes: Means with the same superscript= do not differ significantly at $p \leq 0.05$ within the. Means with a different superscript= significantly different ($p \leq 0.05$). F= frozen cowpea grain samples. NF= non frozen cowpea samples. A, B, C, D, E and F= different cowpea varieties; A= IT97k-461-4; B= IT89KD-391; C= Potasko Brown; D= IT89KD-288; E= IT97K-82-2; F= Potasko White.

Table 1 shows the results of the get strength of moi-moi samples prepared from wet-milled cowpea varieties soaked at different time intervals (1hr, 2hrs and 3hrs). The gel strength (penetration rate) of the samples from wet-milled cowpea grains ranged from 127.34–173.70 g/mm2, 143.87–194.00 g/mm2, and 165.37–243.93 g/mm2 for soaking time of 1hr, 2hrs and 3hrs respectively. Samples with higher values of penetration (g/mm2) have much more tenderness and lower gel strength. Gels are viscoelastic substances usually formed by the interactions of polysaccharides and proteins in food matrix (Awuchi et al., 2019). As the soaking time increases across the table, the tenderness of the moi-moi samples increases. Thus, the gel strength decreases. Also, careful observation from the table showed that moi-moi samples prepared from frozen cowpea grains have lesser gel-strength than those prepared from non-frozen cowpea grain. Ji et al. (2017) reported increase in gel strength of rice flour as flour concentration increases (Ji et al., 2017). The gel strength of samples AF, ANF, BNF, CF and CNF are significantly ($P>0.05$) same but differ significantly ($P<0.05$) amongst others at 1hr soaking time. The gel strengths of samples DNF and EF were also significantly ($P>0.05$) same. At 2hrs soaking time, the results of the gel strength showed that samples AF, ANF and BF are significantly ($P>0.05$) same. This also is same with those of samples BNF, CF and CNF, which are significantly ($P>0.05$) indifferent. At 3hr soaking time, the gel strength results of most samples differ significantly ($P<0.05$) while those of CF and CF are significantly ($P>0.05$) same. This is also with those of samples DNF and EF, ENF and FF.

Table 2. Gel strength of moi-moi samples prepared from dry-milled cowpea grains soaked at different time intervals.

Samples	Gel strength (penetration rate) of moi-moi at different soaking time (g/mm^2)		
	1hr	2hrs	3hrs
A_F	242.60a ± 2.25	294.03a ± 1.67	344.97a ± 4.97
A_{NF}	237.63b ± 2.37	286.80b ± 1.21	327.77b ± 5.14
B_F	215.93d ± 3.35	259.90c ± 2.25	291.80d ± 4.85
B_{NF}	216.27d ± 1.10	242.73de ± 3.93	264.73fg ± 8.37
C_F	221.20c ± 2.42	263.40c ± 1.73	299.30c ± 1.21
C_{NF}	207.63e ± 2.54	244.67d ± 2.89	280.00e ± 5.72
D_F	199.50f ± 0.87	239.40e ± 2.77	271.80f ± 2.25
D_{NF}	197.40f ± 2.60	234.00f ± 5.02	263.47g ± 6.00
E_F	190.70g ± 4.16	229.27f ± 1.96	259.17g ± 2.14
E_{NF}	187.07g ± 0.06	222.67g ± 3.18	240.00h ± 0.87
F_F	174.70h ± 1.04	205.27h ± 4.21	228.63i ± 2.66
F_{NF}	169.73i ± 0.46	191.73i ± 1.44	210.97j ± 0.64
LSD	2.264	2.927	4.404

Notes: Means with the same superscript= do not differ significantly at $p \leq 0.05$ within the. Means with a different superscript= significantly different ($p \leq 0.05$). F= frozen cowpea grain samples. NF= non frozen cowpea samples. A, B, C, D, E and F= different cowpea varieties; A= IT97k-461-4; B= IT89KD-391; C= Potasko Brown; D= IT89KD-288; E= IT97K-82-2; F= Potasko White.

The results of the gel strength of moi-moi prepared from dry-milled cowpea grains varieties soaked at different time intervals (1hr, 2hrs and 3hrs) are sown in Table 2. The gel strength (penetration rate) of moi-moi prepared from dry-milled cowpea grain samples ranged from 169.73 – 242.60 g/mm2, 191.73 – 294.03 g/mm2, and 210.97 – 344.97 g/mm2for 1hr, 2hrs and 3hrs of soaking time respectively. Samples with higher values of penetration (g/mm2) have much more tenderness (lower gel strength). The tenderness of the moi-moi samples increases as the soaking time increases across the table. This may be due to the uptake of moisture by the polysaccharides (mostly starch) and protein in the flour (Awuchi et al., 2019; Hannington et al., 2020). Hence, the gel strength decreases. Observing from the table, it can be deduced that moi-moi samples prepared from non frozen cowpea grains have higher gel-strength than those prepared from frozen cowpea grain. The gel strength of samples AF, ANF, BF, CF, CNF, DF, EF, FF and FNF are significantly ($P<0.05$) different at 1hr soaking time. The gel strengths of samples AF and FNF were the least and highest respectively. The results of the gel strength at 2hrs soaking time, showed that samples BNF and CNF, BNF and DF, DNF and EF are significantly ($P>0.05$) same. The result of other samples at 2hrs differ significantly ($P<0.05$). At 3hr soaking time, the gel strength results of most samples were significantly

(P<0.05) different while those of BNF and DF are significantly (P>0.05) same. This is also same with those of samples DNF and EF. Samples AF and FNF had the least and highest gel strength respectively.

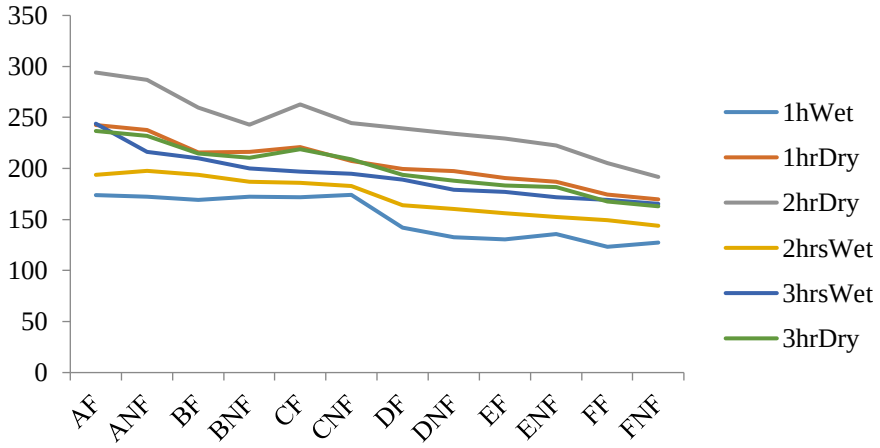

Fig. 3. Diagram of graph plot of gel-strength against samples. F= frozen cowpea grain samples; NF= non frozen cowpea samples; A, B, C, D, E and F= different cowpea varieties; A= IT97k-461-4; B= IT89KD-391; C= Potasko Brown; D= IT89KD-288; E= IT97K-82-2; F= Potasko White.

The Fig. 3 shows the gel strength of samples with regard to the different pre-milling treatments. The graph showed that moi-moi prepared from cowpea grains soaked for 1hr had the highest gel strength followed by the samples prepared from cowpea grains soaked for 2hrs. Samples prepared from dry-milled cowpea soaked for 2hrs had the least gel strength. Results show that freezing and soaking had significant influence on the gel strength of the samples. This may be due to the fact that freezing reduces moisture content and denatures protein and starch molecules and longer during of soaking time causes leaching of food components. Deterioration of food components have been reported in frozen foods (Feng et al., 2020). Agarwal (2016) concluded in his study that soaking has significant impacts on food compositions.

CONCLUSION

Soaking is a preservation and processing technique involved in preparation of some indigenous food products such as moi-moi. Freezing is a preservation that is employed to check postharvest losses while soaking aids in processing such as dehulling. The gel strength (penetration rate) of the samples from wet-milled cowpea grains ranged from 127.34–173.70 g/mm2, 143.87–194.00 g/mm2, and 165.37–243.93 g/mm2 for soaking time of 1hr, 2hrs and 3hrs respectively. Samples with higher values of penetration (g/mm2) have much more tenderness and lower gel strength. The gel strength (penetration rate) of moi-moi prepared from dry-milled cowpea grain samples ranged from 169.73–242.60 g/mm2, 191.73–294.03 g/mm2, and 210.97–344.97 g/mm2 for 1hr, 2hrs and 3hrs of soaking time respectively. The tenderness of the moi-moi samples increases as the soaking time increases across the table. The graph showed that moi-moi prepared from cowpea grains soaked for 1hr had the highest gel strength followed by the samples prepared from cowpea grains soaked for 2hrs. Samples prepared from dry-milled cowpea soaked for 2hrs had the least gel strength. Moi-moi samples prepared from non-frozen cowpea grains have higher gel-strength than those prepared from frozen cowpea grain. Both freezing and soaking time affect the quality attribute of food products. This research work focused on the effect of freezing and soaking time on the gel strength of moi-moi prepared from selected varieties of cowpea grains. The research work also provides literature for further studies on gel strength of moi-moi as little or less work has been done on this aspect.

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