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Research Article

Concentration Effect on Foaming and Stability of Isolates from Two Varieties (DAS & BS) of Nigerian Cultivated Solojo Cowpea (*Vigna Unguiculata L. Walp*)

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Abstract

Concentration Effect on foaming capacity and stability of the various samples were investigated. Foaming capacity of raw (native/ control) and germinated Dark-ash Solojo Cowpea (FFDAS, DFDAS, FFBS and DFBS flours; DAS and BS protein isolate) were all concentration dependent. The four flour samples, FFDAS, DFDAS, FFBS and DFBS as well as the two protein isolates exhibited rise in foam capability with rise in concentration but to different degrees. The difference was manifested not only between the full fat and defatted but also varietal wise. The foaming capacity of the Raw FFDAS, 6h FFBS and Raw DFBS increased only up to 4% concentration before experiencing a decrease in foam capacity. FFDAS 24h; DFDAS Raw and 48 h; FFBS Raw, 24h, 36h and 48h; DFBS 24h; DAS isolate Raw and 36 h; BS isolate 24h, 36h and 48h all had their foaming capacity going up to 6% concentration. FFDAS 6h, 36h, 48h and 72h; DFDAS 6h and 72h; FFBS 72h, DFBS 36h and 72h; DAS 24h, 48h and 72h; BS Raw, 6h and 72h all had their foaming capacity increasing up to 8% concentration, while only DFDAS 24h, 36h and DFBS 6h and 48h had their foaming capacity increase to 10% concentration. The FC ranged between 17.30±1.52 – 88.68±1.65%; 61.78±0.21 – 106.83± 1.06%; 37.62±0.98 – 92.08±1.01%; 64.15±0.34 – 107.27±0.07%; 94.62±2.23 – 188.30± 1.57%; 109.66±3.29 – 151.67±2.52% for FFDAS, DFDAS, FFBS, DFBS, DAS and BS respectively. The Foaming Capacity (FC) for FFDAS increased with germination except at lower concentration of 2-4%. That of DFDAS showed a better response. The FC was higher than that of the FFDAS, this could be as a result of the exposure of more hydrophilic sights as a result of defatting. The DFBS likewise exhibited a higher FC compared to that of FFBS. The FC of the flours of brown solojo was found to be higher than that of the dark-ash solojo cowpea. The isolates had higher FC, with DAS having higher FC than the BS. Increase in concentration enhances greater protein-protein interaction, which increases viscosity and facilitates formation of multilayer protein film at the interface. The formation of cohesive multilayer film offers resistance to disproportional and coalescence of bubbles. In addition, increase in concentration could lead to formation of thicker films, which limits the effect of drainage of protein from films.

Keywords: BS; DAS; Essential amino acids; Food industry; Nutraceuticals; Solojo Cowpea; Under-utilized legumes

Introduction

Cowpea (*Vigna unguiculata*) is among the pulse's species of greatest economic and social importance. This legume is strategic for the food security and health of millions of people in the world. Cowpea is rich in nutraceutical compounds such as dietary fibre, antioxidants and polyunsaturated fatty acids and polyphenols, whose health benefits and use in the food industry have been extensively studied. However, research on the identification of functional proteins from cowpea, their metabolic functions and applications in the food, health and other industries are still scarce.

The whipping character and potential of flours and protein isolates of legumes is depicted by foaming property of the legume. This is because, proteins foam on whipping due to their surface-active properties [1]. The inter-facial scope that can be formed by the protein determines the foaming capacity (FC) of the protein. While capability of protein to maintain foam contrary to environmental pull and internal forces is foaming stability [2]. Foaming capacity is hinged on the capability of proteins to imbibe swiftly at the air- water interface during vigorous mixing, while stability of foam is dictated by the attribute of the various layers of consistent films around the air suds that gives protection contrary to fluid leakage and droplet fusion. Foaming capability and stabilization power are restricting factors in the classification of the functionality of proteins [3].

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The interfacial (surface) layer produced by proteins that sustains the froths in suspension and reduce the extent of coming together of the bubbles determines foaming capacity. The characteristic of any food foam is determined not only by the proteins but by other composition of the matrics, carbohydrates and fat existing in the flours as an example [4-6].

According to Adebowale and Lawal [7], foam formation generally increases till it reaches a peak value as the quantity of protein rose and thereafter fell. This was possibly as a result of the high lipid content at the higher concentration. Fats, when existing at quantities in excess 0.5% considerably debilitate the foaming capacity of protein for the reason that oils are more facially energetic than are proteins because of their hydrophobicity and so interact better with the air and so easily absorb at the junction between air water (interface) and prevents absorption of proteins at the time of foam formation [8].

Lawal et al. [9], similarly, observed decrease in foam stability for chemically modified bambara groundnut protein, likewise, Lawal and Dawodu [10], observed same for both native and maleylated protein derivatives of African locust bean protein isolates. This was attributed to increase in charge density of succinylated proteins, since protein and protein interaction was inhibited by it. Lawal et al. [11], also noticed a similar reduction in foam stability with rise in concentration for full fat African locust bean flour. Oil films lack the close-knit and visco-elastic properties of the foam bubbles, they swiftly expand and then breakdown; this could be the reason for decrease in FS with rise in concentration. Reduction in FS might also be due to protein unfolding.

Various foaming capacity ranges have been reported for different legumes, 30.4% - 44.3% for Chickpea cultivars [1]; while Adebowale and Lawal [7], reported a value of 58% for Mucuna bean protein concentrate. Germination was also noticed as improving the FC and FS for the BS samples than the DAS samples. Bamdad et al. [12], likewise observed an improvement in FC of germinated lentil when compared with the ungerminated. The germinated isolate samples exhibited similar trend to that shown by chemically modified isolates as well as the enzymatically modified protein isolates.

Materials and Methods

Two varieties of the underutilized cowpea (*V. unguculata*) found in South west region of Nigeria where it is called 'Solojo' were used. Seeds obtained from Bodija market in Ibadan, Western Nigeria, were screened to get rid of every irrelevant materials and unwholesome seeds. The beans were then portioned into six (6). The Solojo seeds for germination were sterilised by soaking in 0.07% Sodium hypochlorite for 30min, then, it was rinsed thoroughly. The Solojo seeds were then immersed for 6h in distilled water at ambient temperature (1:10 w/v) (~25˚C), then placed in a colander and germinated under subdued light in an open laboratory for, 24, 36, 48 and 72h.

Preparation of flours

Raw flour: The grains were segregated to remove the spoilt ones; then dry dehulled with a mechanical dry dehuller (Fabricated in FIIRO), dried at 40˚C and later milled dry to powder then sifted using 80µm mesh. The flour was stored in flexible bags and preserved at 4˚C preceding utilization in a refrigerator freezer.

6h soaked flour: The seeds were segregated to remove the unwholesome ones, then immersed for 6h in the ratio (1:10 w/v) (seed/water). The grains were then frozen to prevent germination from setting in, then the hull was removed manually, dried for 48h at 40˚C later milled dry to smooth powder prior to sieving using 80µm mesh screen. The resulting flour was packaged in plastic pack and preserved in a fridge-freezer at 4˚C pending utilization.

Germination of seed: This was implemented by the method of Mubarak AE [13], with minor adjustment. The seeds for germination were disinfected by soaking in 0.07% Sodium hypochlorite Rumiyati, AP and James VJ [14], for 30mins, then, it was rinsed painstakingly. The Solojo seeds were then immersed for 6 hours at ambient temperature in water in the ratio (1:10 w/v) (seed/water) (~25°C), then placed in a colander and germinated under subdued light in an open laboratory Rusydi MR, Noraliza CW, Azrina A and Zulkhairi A [15], for various hours such as 24, 36, 48 and 72h. The process of germination was terminated by freezing, the seeds were manually dehulled, dried in a draught oven (Schutzart DIN EN 60529-IP 20. Memmert, Germany) at 40˚C for 48h, cooled, milled and packaged in an air tight plastic bag in the refrigerator pending analysis (Figures 1-3).

Figure 1: Brown Solojo Cowpea.

Figure 2: Dark-Ash Solojo Cowpea.

Discussion of Experimental Results

The impact of concentration on foaming characteristics is presented in tables 1-12. A similar observation of increase in foaming capacity up to a certain concentration before falling was observed by Lawal et al. [11], for *Parkiabiglobosa* flour as reported by [16].

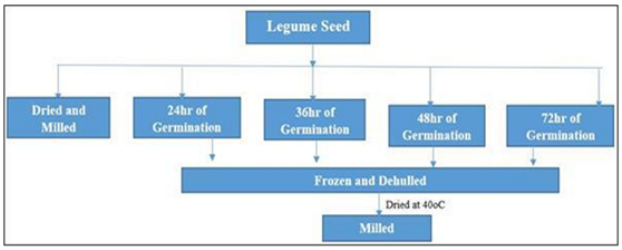

Figure 3: Preparation of Beans Flour/Schematic representation.

FF-DAS	2%	4%	6%	8%	10%
Raw	67.21±1.24a	69.42± 1.95a	59.56± 1.36c	71.09± 1.55e	62.02±1.77cd
6h	66.04±2.33ab	70.96±2.41b	80.14±3.73b	84.25±0.52a	81.55±1.68a
24h	63.16±3.29b	67.31±0.31b	88.68±1.65a	70.97±4.93c	63.69±4.80cd
36h	38.48±1.54c	58.89±2.42c	67.95±2.88c	78.72±1.56b	65.76±0.30c
48h	17.30±1.52d	30.55±3.60d	53.71±0.50d	63.64±0.58d	60.72±0.54d
72h	39.04±0.58c	77.78±0.93a	79.49±5.00b	82.32±0.87ab	74.24±1.61b

Table 1: Effect of concentration on foaming capacity (%) of (FFDAS).

Note: FFDAS- Full fat dark ash Solojo Cowpea; Means in colomn not followed by same alphabet(s) are significantly different at 5% level (P<0.05).

The foaming capacity increased to 6% before falling. The foaming capacity ranged between 47.8±0.9 and 79.1±1.9% for the undefatted African locust bean and between 66.4±0.8 to 93.6±2.1% for the defatted African locust bean flour. Yellavila et al. [6], reported the foaming capacities of the different legume flours of five lima beans sample to range from 19.21% to 22.13%. These observed values were lower than that obtained for the germinated samples both for the full fat and defatted. While that of African locust bean compared favorably with those of the flours. However, Akubor and Badifu [17], recorded a FC value of 40% for Wheat flour.

DF-DAS	2%	4%	6%	8%	10%
Raw	72.41±1.26c	78.44±0.94f	86.55±0.95d	78.95±0.18f	84.76±0.83d
6h	71.97±1.19c	88.13±1.05b	93.17±1.06b	97.60±1.01b	94.59±1.75b
24h	69.56±1.17d	80.31±1.02d	91.39±1.05c	94.51±3.12c	94.57±1.72b
36h	61.78±0.21e	86.46±1.11bc	86.58±1.09d	91.47±1.04d	91.49±1.07c
48h	72.15±1.03c	84.74±1.10c	93.38±1.10b	87.95±0.99e	100.61±1.05a
72h	85.89±1.24b	97.48±1.12a	97.81±0.53a	106.83±1.06a	101.22±1.05a

Table 2: Effect of concentration on foaming capacity (%) of (DFDAS).

Note: DFDAS- Defatted dark ash Solojo Cowpea; Means in colomn not followed by same alphabet(s) are significantly different at 5% level (P<0.05).

The observed increase in foaming capacity of the germinated DAS and BS protein isolate is also similar to that reported by various other researchers such as; [9,10,18], for Mung bean protein isolate; succinylated and acetylated protein isolates; native and maleylated protein derivatives of African locust bean protein isolates) they all reported significant increase of foaming capacity and stability with rise in sprouting period and increase in chemical modification respectively. A similar increase was also reported for microbial transglutaminase treated *Cajanuscajan* and *Lablab purpureus* protein isolates by Ali et al. [19]. These could be due to increase solubility of protein.

FFBS	2%	4%	6%	8%	10%
Raw	71.88±1.11a	73.09±0.86c	75.42±2.03c	72.29±2.47c	67.25±0.78d
6h	64.85±1.22b	84.76±0.15a	84.54±0.51a	83.90±1.12b	84.34±0.98b
24h	42.86±0.48d	51.77±0.27f	64.88±0.79d	62.85±0.76e	62.42±1.05e
36h	37.62±0.98e	64.71±0.19e	65.64±1.16d	65.25±1.53d	68.29±0.93d
48h	43.41±0.99d	66.77±0.48d	80.13±1.03b	73.86±0.90c	70.21±0.98c
72h	54.55±0.61c	78.23±1.05b	85.49±1.13a	92.08±1.01a	90.28±1.03a

Table 3: Effect of concentration on foaming capacity (%) of full fat brown solojo cowpea (FFBS).

Note: FFBS- full fat brown Solojo Cowpea flour.

A very important factor in foaming capacity is the rapidity in which protein lowers the surface tension, smaller, elastic and transformed proteins diminish the surface pressure more readily and easily, compared with other firmer and bigger proteins. The prominent protein fraction in the isolate also affects the foaming capacity, for example if the globulin fraction is higher than the albumin, the foaming capacity is found to be less than the isolate with higher albumin. This is because, albumins are more water soluble than globulins. The observed reduction in foaming capacity at 6% and 8% may be due to insufficient electrostatic repelling, cummulating in insufficient solubility and hence too much protein-protein interplay**.** The rate of foaming of flour has also been associated with the quantity of native protein in the sample.

DFBS	2%	4%	6%	8%	10%
Raw	78.24±1.54bc	93.12±2.89b	91.95±1.05b	87.95±0.99e	88.50±1.94e
6h	80.95±0.18a	96.89±1.06a	100.02±3.25a	101.84±0.02c	103.04±1.09b
24h	76.92±0.22c	92.45±0.07b	101.85±0.02a	94.59±0.05d	98.19±0.02c
36h	73.71±1.33d	85.18±0.14d	88.99±0.10b	101.82±0.02c	94.55±0.05d
48h	79.24±0.20b	89.09±0.10c	100.02±3.16a	107.27±0.07a	107.27±0.07a
72h	64.15±0.34e	85.58±0.01d	89.09±0.09b	105.36±0.05a	94.59±0.05d

Table 4: Effect of concentration on foaming capacity (%) of defatted brown solojo cowpea.

Note: DFBS-Defatted brown Solojo Cowpea flour; Means in colomn not followed by same alphabet(s) are significantly different at 5% level (P<0.05).

DAS	2%	4%	6%	8%	10%
Raw	94.62±2.23d	144.09±3.24b	152.43±3.16b	142.51±2.04d	140.19±2.42c
6h	131.33±1.15a	152.67±3.06a	155.33±5.03b	162.00±2.00c	175.33±1.15a
24h	117.33±2.31c	125.00±1.73cd	128.67±1.15c	132.83±1.04d	128.92±1.01d
36h	116.67±1.15c	121.33±2.31d	132.67±1.15c	124.33±0.58e	124.17±3.62e
48h	118.00±2.00bc	128.33±1.53c	161.67±1.53a	188.30±1.57a	143.33±3.06bc
72h	121.00±1.00b	122.83±2.57d	152.67±1.15b	165.00±1.73b	145.22±1.35b

Table 5: Effect of concentration on foaming capacity of (%) DAS protein isolate.

Note: Dark-ash Solojo Cowpea protein isolate; DAS Means in colomn not followed by same alphabet(s) are significantly different at 5% level (P<0.05).

Foaming ability is not only influenced by the nature of protein and fat, it is also affected by pH, method of processing, temperature, whipping method, presence or absence of sugar and salt such as calcium ion, duration of heating as well as solubility**.** Foam capacity was also observed to reduce with germination time up to 36hrs, but increased again from 48h. This was also observed by Akaerue and

Onwuka [20], for germinated Mung bean. Igbabul et al. [21], likewise expressed decrease in FC with rise in fermentation time for *Mucunasloanei* and *Detariummicrocarpum*.

BS	2%	4%	6%	8%	10%
Raw	109.66±3.29c	123.35±2.25cd	127.28±2.36c	137.55±3.17b	120.83±2.03d
6h	114.67±3.06bc	126.67±3.06bc	140.00±2.00ab	151.67±2.52a	136.67±1.15b
24h	131.33±4.16a	140.67±3.06a	143.33±4.16a	131.33±4.16c	143.33±3.06a
36h	116.00±2.00b	122.00±2.00d	127.33±3.06c	123.33±3.06d	118.00±2.00d
48h	113.33±1.15bc	128.00±2.00b	144.67±3.06a	130.67±1.15c	136.67±1.15b
72h	127.00±3.00a	129.67±2.08b	137.33±1.15b	149.67±1.53b	130.00±2.00c

Table 6: Effect of concentration on foaming capacity (%) of BS protein isolate.

Note: BS-Brown Solojo Cowpea protein isolate; Means in colomn not followed by same alphabet(s) are significantly different at 5% level (P<0.05).

Foam Stability (FS) for all the samples improved with rise in concentration as shown in Tables 1-6. The FS is essential as the advantage of whipping agents lies on their ability to preserve the whip as long as possible**.** Foaming Capacity (FC) and Foam Stability (FS) of flours and isolate from different Solojo cowpea accession were also observed to differ significantly, this is also observed for different chickpea cultivars as reported by Kaur and Singh [22]. Sreerama et al. [23], also observed that *Vigna unguiculata* flour possess higher capacity to create stable and united coating round air bubble thereby creating more opposition to air migration from the bubbles, hence better foam stability.

FF-DAS	2%	4%	6%	8%	10%
Raw	31.81±3.99a	37.28±2.23b	47.01±0.85b	41.57±0.85b	41.34±0.57b
6h	35.62±1.16a	51.56±1.77a	53.74±1.90a	63.99±2.13a	62.16±1.20a
24h	31.14±4.25a	38.46±0.59b	38.72±3.21c	40.04±3.77b	40.63±3.07b
36h	18.27±1.97b	27.74±3.05c	35.54±0.57c	37.08±3.88b	34.25±1.98c
48h	11.88±2.54c	12.59±1.29e	24.07±0.70e	23.94±1.85c	14.29±1.55d
72h	17.45±1.83b	20.00±1.66d	29.20±2.91d	37.80±1.93b	41.73±2.38b

Table 7: Effect of concentration on foam stability (%) of FFDAS after 4 h at room temperature (30±2oC).

Note: FFDAS- Full fat dark ash Solojo Cowpea; Means in colomn not followed by same alphabet(s) are significantly different at 5% level (P<0.05).

Decrease in foam volume with time was observed with all the samples, this was equally observed by Arawande and Borokini [24], for *Canavaliaensiformis*, *Cajanuscajan* and *Vignaunguiculata* flours with values reducing from 20.67±0.41 to 10.33±0.41; 3.53±0.36 to 3.05±0.10; and 16.33±0.37 to 15.70±0.31% respectively. The foam stability values ranged between 11.88±2.54 - 63.99±2.31%; 15.82±1.39 - 88.57±2.64%; 27.16±0.40 - 60.07±1.01%; 45.74±0.95 - 96.36±0.03%; 57.33±3.06 -125.18±4.60; 63.48±2.93 - 106.67±2.31%. For, FFDAS, DFDAS, FFBS, DFBS, DAS and BS respectively. The values of foam stability were however higher than those obtained by Arawande and Borokini [24], for *Canavalia ensiformis* and *Cajanuscajan* but compareable to that of Cowpea, which were 10.33±0.41, 3.05±0.10 and 15.70±0.31% respectively. Also reported values of 1.96±0.36 and 0.16±0.03% respectively for two species of Vigna subterranean VS1 and VS2 respectively.

D F - DAS	2%	4%	6%	8%	10%
Raw	31.43±2.75b	37.61±1.54c	49.84±1.48a	48.53±1.43a	48.97±0.69a
6h	32.48±0.97e	60.63±1.70d	77.33±1.31c	84.96±2.60b	88.57±2.64a
24h	30.75±1.08e	42.15±1.25d	61.24±1.67c	79.21±0.89b	83.06±2.47a
36h	18.48±2.50e	31.70±3.04d	46.34±0.77c	65.25±1.67b	72.64±0.14a
48h	15.82±1.39e	34.14±2.13d	48.20±2.38c	65.09±4.20b	81.33±0.84a
72h	44.88±1.77d	59.13±2.66c	72.51±2.73b	81.36±1.93a	83.54±0.09a

Table 8: Effect of concentration on foam stability (%) of DFDAS after 4 h at room temperature (30±2oC).

Note: DFDAS- Defatted dark ash Solojo Cowpea; Means in colomn not followed by same alphabet(s) are significantly different at 5% level (P<0.05).

Chinma et al. [25], observed increase in foaming capacity with germination time, with 8.60±0.70% - 12.91±0.61% for the brown variety of tigernut flour, and 7.75±1.50 – 11.40±0.56% for the yellow variety tigernut flour. This value was however found to be lower than that obtained for the samples in this study. According to Arawande and Borokini [24]**,** foaming capacity as low as 16.33±0.37 and 20.67±0.41% can be used as aerifying agents in food arrangement such as "bean balls" and 'bean pudding' which needs the production of lasting huge fluffy volumes when whipped. *Cucumeropsismannii* seed flour protein isolate, with foaming capacity and stability of 30.00±1.00 and 5.00±1.00% have been found to be useful in the production of ice-cream and yogurt which is in agreement with the findings of Ogunbusola et al. [26].

FFBS	2%	4%	6%	8%	10%
Raw	36.73±0.92a	42.38±1.62a	41.91±2.29c	45.73±2.58c	43.87±2.61cd
6h	27.16±0.40cd	31.44±2.74b	29.97±1.57d	32.50±2.35d	32.53±0.34e
24h	27.28±0.30cd	31.83±0.98b	50.00±1.26ab	44.89±1.25c	41.82±1.82d
36h	28.94±1.75c	42.42±1.60a	50.31±1.62ab	56.11±1.45b	51.84±1.61b
48h	26.69±1.59d	41.62±0.76a	48.45±0.97b	45.29±0.29c	45.29±1.58c
72h	31.17±0.35b	42.59±0.97a	52.68±1.90a	60.07±1.01a	59.88±1.65a

Table 9: Effect of concentration on foam stability (%) of FFBS after 4h at room temperature 30oC±2.

Note: FFBS-Full fat brown Solojo Cowpea flour; Means in colomn not followed by same alphabet(s) are significantly different at 5% level (P<0.05).

DFBS	2%	4%	6%	8%	10%
Raw	45.74±0.95c	48.75±0.97d	58.53±1.61e	59.64±0.62f	61.24±2.08e
6h	50.49±2.92b	70.10±1.75a	77.27±2.14b	81.65±0.17c	80.03±2.81c
24h	53.21±1.85ab	60.38±0.37b	79.63±0.19b	76.58±0.21d	87.99±1.05b
36h	51.92±0.46ab	54.32±1.15c	61.47±0.35d	72.73±0.25e	70.91±0.26d
48h	54.72±1.71a	58.17±2.20b	83.49±0.15a	90.91±0.08a	96.36±0.03a
72h	47.17±0.50c	58.56±0.37b	73.95±1.91c	89.29±0.10b	85.58±0.13b

Table 10: Effect of Concentration on Foam stability (%) of DFBS after 4 h at room temperature 30oC±2.

Note: DFBS-Defatted brown solojo cowpea flour; Means in colomn not followed by same alphabet(s) are significantly different at 5% level (P<0.05).

Reduction in foam quantity with time was observed in all protein isolates. These were also the observation of all previous researchers like [3], for Quinoa protein isolate; for Gourd melon; for Cowpea, Pigeon pea, Pea and Mung bean [11], for native and succinylated Lablab concentrate, Mucuna bean protein concentrate [27,28].

DAS	2%	4%	6%	8%	10%
Raw	59.53±1.28e	114.68±1.33a	125.18±4.60a	114.39±4.27b	106.69±2.42c
6h	76.33±1.53d	108.33±1.53b	120.67±1.15a	121.33±1.53a	125.33±2.31a
24h	57.33±3.06e	108.33±1.53b	112.67±1.15b	116.58±1.23b	112.67±1.15b
36h	96.67±1.15a	101.58±1.42c	109.67±2.08b	85.33±2.31d	76.67±1.15e
48h	86.53±3.11c	97.33±2.31d	98.25±2.05c	109.67±2.08c	98.00±2.00d
72h	92.67±1.15b	97.00±1.00d	121.33±2.31a	124.67±1.15a	100.67±1.15d

Table 11: Effect of concentration on foam stability (%) of DAS protein isolate after 4h at room temperature 30oC±2.

Note: DAS-Dark- ash solojo cowpea protein isolate; Means in colomn not followed by same alphabet(s) are significantly different at 5% level (P<0.05).

BS	2%	4%	6%	8%	10%
Raw	63.48±2.93d	89.40±0.95bc	91.44±2.58bc	100.18±2.28a	106.20±1.09a
6h	69.33±3.06c	82.67±2.31d	95.33±1.15ab	104.67±4.16a	106.67±2.31a
24h	85.33±4.62a	88.00±3.46c	96.67±4.16ab	88.00±2.00b	92.67±4.16b
36h	70.00±2.00c	93.33±3.06ab	100.67±4.16a	70.00±2.00c	66.00±3.46d
48h	74.67±3.06bc	97.33±2.31a	101.33±4.16a	103.33±3.06a	96.67±4.16b
72h	76.33±1.53b	82.33±2.52d	88.67±2.08c	102.33±2.08a	85.33±1.53c

Table 12: Effect of concentration on foam stability (%) of BS protein isolate after 4h at room temperature 30oC±2.

Note: BS-Brown solojo cowpea protein isolate; Means in colomn not followed by same alphabet(s) are significantly different at 5% level (P<0.05).

Conclusion and Recommendation

Biochemical modification which involves the activation of the intrinsic enzymes of the Solojo cowpea seed itself by germination was carried out for different hours for the two varieties, i.e. the Dark-Ash and the Brown Solojo beans. This research work shows that biochemical modification (Germination/Malting/ Sprouting) had an enormous impact on the nutritional composition, functional properties, mineral bioavailability, anti-nutrient content and amino assay of Solojo bean, thus, it could be used as protein supplement in infant, young children and geriatric foods.

Efforts should be increased to promote the cultivation, encourage the consumption and industrial application of this underutilized legume by the Government, especially in the south-western region where it can survive the rain fall level. Large scale production of this legume which is gradually going into extinction should be encouraged in order to fight the menace of malnutrition in developing countries where animal protein price is exorbitant; This will ensure food security and also creation of jobs, because people can engage in different aspects of the production process and thereby reducing the rate of unemployment.

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