Physical and Cooking Properties Affected by Sprouting with Multivariate Approach on GNG 469 Chick pea Seed Cultivar

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ABSTRACT

The present study was undertaken to determine the effect of sprouting hours on physical and cooking properties of tropical GNG 469 cultivar of Chick pea. Sprouting for 48 hours increases L value from 38.40 to 19.87, a* 2.89 to 6.88, bulk density 0.83 to0.69 g/ml, dry matter loss from 0 to 3.72 %, cooking time 77.15 to 33.47 minutes, gruel solid loss 11.99 to 15.61 %, water uptake ratio 2.35 to 2.77 %, cooked l/b ratio 1.16 to 1.26, swelling capacity 0.15 to 0.28 %, swelling index 1.35 to 1.59% and decrease the colour value b* from 26.85 to 10.60. The sprouting of GNG 469 cultivar of Chick pea had a significant effect ($p<0.05$) on physical and cooking properties for 48 hours. Strong and positive correlations exhibited among physical and cooking properties of tropical GNG 469 cultivar of Chick pea. Multivariate analysis proved to be an effective tool in classifying and analysing the physical and cooking properties affected by sprouting from 0 hours to 48 hours.*

Keywords Correlations, Dry matter, Multivariate, Sprouting, Cooking.

I.INTRODUCTION

Chickpea (*Cicer arietinum L.*) is an important pulse crop grown and consumed all over the world, especially in the Afro-Asian countries. It is a good source of carbohydrates and protein, and the protein quality is considered to be better than other pulses. Chickpea has significant amounts of all the essential amino acids. Starch is the major storage carbohydrate followed by dietary fiber, lipids are present in low amounts but chickpea is rich in nutritionally important unsaturated fatty acids like linoleic and oleic acid [1]. The chickpeas contain moderately high protein (17–22%), low fat (6.48%), high available carbohydrate (50%) and crude fiber content of 3.82% on dry basis [2]. The available carbohydrate is mainly starch which is reported to be slow digestible, thus eliciting low glycaemic responses in human nutrition. Hence chickpea seeds can play an important role as a low-glycaemic functional ingredient in a healthy diet [3]. Chickpea are considered a good source of dietary protein because of their well-balanced amino acid composition, high protein bioavailability, relatively low levels of antinutritional factors and high biological value [4]. The physical properties are important in designing equipments related to handling, harvesting, processing and storage of black gram [5]. Physical properties also played a important role in transport of materials by conveying system. The limitation of legumes consumption is due to antinutritional factors that reduce the availability and digestibility of nutrients [6]. Cooking and sprouting are most common method for increasing digestibility, palatability and reduction of antinutritional factors [7]. Prior to cooking and sprouting, legumes are soaked in water in order to save time and energy for few hours to overnight [8]. The sprouting improves quality of nutrients and functional properties of seeds due to increasing in bioactive components [9]. The present study was undertaken to evaluate effect of sprouting on temperate chick pea GNG 469 cultivar for physical and cooking properties.

II. MATERIALS AND METHODS

2.1 Materials

The GNG 469 chick pea cultivar was procured from pulse research station SKUAST Jammu and were cleaned, soaked for 12 hrs, germinated in incubator for 12, 24, 36, and 48 hours, dried at 45 °c in drier.

2.2 Methods

The colour by hunter lab colorimeter, bulk density according to method [10], dry matter loss by AOAC method [11], Gruel solid loss, water uptake ratio, cooking time, cooked l/b ratio, swelling capacity and swelling index were determined following Adebowale method [12].

III. RESULTS & DISCUSSION

3.1 Physical and cooking properties of GNG 469 Chick pea seed Cultivar

3.1.1 Physical properties

Colour profile of GNG 469 Chick pea seed Cultivar is presented in Table 1. L* value was observed in range 38.40 to 19.87. The highest L* value 38.40 was observed for 0 hour germination period and lowest L* value 19.87 for 48 hours of germination period. There was significant decrease in L* value with increasing germination period from 0 to 48 hours. The colour a* value varied from 2.89 to 6.88. The highest a* value of 6.88 was found in 48 hour germination period and lowest a* value in 0 hour germination period. With increase in germination period up to 48 hours in GNG 469 Chick pea seed there is significant increase in a* colour value. The colour b* value in GNG 469 Chick pea seed due to different germination period showed significant decrease from 26.85 to 10.60. The higher b* value of 26.85 was revealed in 0 hour germination period and lower b* value of 10.60 in 48 hours of germination period. The effect of different hours of germination period on colour profile in term of L*, a*and b* values in GNG 469 Chick pea seed Cultivar showed significant differences (p≤0.05).

Bulk density of GNG 469 Chick pea seed Cultivar showed in Table 1 revealed that bulk density decreased from 0.83 g/ml to 0.69 g/ml with increased germination period. The highest bulk density of 0.83 g/ml and lowest bulk density of 0.69g/ml were for 0 and 48 hours of germination periods respectively. At 5% level of significance, germination periods on bulk density in GNG 469 Chick pea seed cultivar differ significantly whereas effect of 24, 36 and 48 hours of germination period on bulk density were non-significant with each other. Litreature indicates bulk and true density of kidney bean cultivars were in the range of 0.72 – 0.87 and 1.23 –1.31g/mL, respectively [13].

The data pertaining to the effect of different periods of germination on dry matter loss in GNG 469 Chick pea seed cultivar presented in Table 1 reflects decreasing dry matter loss up to 3.72% when germination periods was increased from 0 to 48 hours. The effect of different germination periods on dry matter loss at 5 % level of significance differ significantly.

3.1.2 Cooking properties

The data in Table 1 revealed that the cooking time of GNG 469 Chick pea seed cultivar was greatly influenced by different germination period. The cooking time decreased from 77.15 to 33.47 minutes with increased germination periods from 0 hour to 48 hours respectively. The cooking time of 77.15 minutes was highest in 0 hour germination period and lowest 33.47 minutes in 48 hours germination periods. At 5 % level of significance, effect of germination periods on cooking time in GNG 469 Chick pea seed cultivar differ significantly with each other whereas 36 and 48 hours of germination on cooking time were non-significant with each other. Cooking time between 42.4 – 97.8 min has been reported for different beans [14]. Williams et al. [15] reported cooking time is a heritable characteristic for pulses.

Gruel solid loss presented in Table 1 showed that gruel solid loss increased with increased different hours of germination period. The higher gruel solid loss of 15.61 per cent and lowest 11.97 per cent were noticed at 48 and 0 hours of germination period in GNG 469 Chick pea seed cultivar. The effect of different hours of germination period on gruel solid loss in GNG 469 Chick pea seed Cultivar showed significant differences (p≤0.05) whereas 24 and 36 hours of germination on gruel solid loss were nonsignificant with each other. Solid loss of 5.28 – 14.98% has been reported for different bean cultivars [16] and 7.2 – 14% for cowpea cultivars [17].

Water uptake ratio data conferred in Table 1 disclosed that water uptake ratio increased with increasing periods of germination hours. The highest and lowest water uptake ratios were 2.77 and 2.35 for 48 hours and 0 hour germination period in GNG 469 Chick pea seed cultivar respectively. Significant difference (p≤0.05) was observed in GNG 469 Chick pea seed Cultivar due to different hours of germination period on Water uptake ratio. Seena and Sridhar (2005) reported water uptake ratio of wild under exploited legumes (*Canavalia cathartica* and *Canavalia maritima*) in the range of 2.1 – 2.22 and 1.17 – 1.73, respectively.

The data of cooked l/b ratio in Table 1 revealed that in GNG 469 chick pea seed cultivar increased with increasing germination periods. The cooked l/b ratio was in range of 1.26 to 1.16, with highest was observed in 48 hours and lowest in 0 hour periods of germination respectively. The increased in germination period on cooked l/b ratio differ significantly ($p \leq 0.05$).

Swelling capacity of GNG 469 chick pea seed cultivar presented in Table 1 showed increased swelling capacity with highest and lowest in range of 0.28 ml/seed to 0.15 ml/seed for 48 hours and 0 hour germination period respectively. At 5 % level of significance, increased in swelling capacity due to different hours of germination differed significantly. Saha et al. [16] reported swelling capacity of kidney bean cultivars in the range of 0.30 – 0.56 mL/seed and 0.91 – 1.39.

The data present in Table 1 for Swelling index exhibited increased with increased germination period. Swelling Index varied from 1.35 to 1.59. The highest Swelling index was observed for 48 hours of germination period and lowest for 0 hour of germination period. The Swelling index differed significantly at 5% level of significance with increased germination periods. The swelling capacity for 24 hours and 36 hours germination period were significantly same with each other. Saha et al. [16] reported swelling index of kidney bean cultivars in the range of 0 0.91 – 1.39.

3.2. Pearson's correlation coefficient between cooking and physical properties

Pearson's correlation coefficients between various properties of GNG 469 chick pea seed cultivar are presented in Table 2. L* value had significant positive correlation with bulk density($r=0.996$, $p \leq 0.05$), b* value ($r=0.974$, $p \leq 0.05$) and cooking time($r=0.967$, $p \leq 0.05$). However it had significant negative correlations with Dry matter loss ($r= -0.983$, $p \leq 0.05$), Gruel solid loss ($r= -0.998$, $p \leq 0.05$), water uptake ratio ($r=-0.993$, $p \leq 0.05$), cooked l/b ratio($r= -0.998$, $p \leq 0.05$), Swelling capacity ($r= -0.997$, $p \leq 0.05$) and swelling Index ($r= -0.997$, $p \leq 0.05$). The a* value had significant positive correlation with dry matter loss ($r= 0.980$, $p \leq 0.05$), Gruel solid loss ($r= 0.991$, $p \leq 0.05$), water uptake ratio ($r=0.996$, $p \leq 0.05$), cooked l/b ratio($r= 0.980$, $p \leq 0.05$), Swelling capacity ($r= 0.995$, $p \leq 0.05$) and swelling Index ($r= 0.989$, $p \leq 0.05$). However it had negative correlation with b* value ($r=-0.964$, $p \leq 0.05$), cooking time($r=-0.967$, $p \leq 0.05$) and bulk density ($r= -0.979$, $p \leq 0.05$). The b* value had significant positive correlation with bulk density ($r= 0.977$, $p \leq 0.05$) and cooking time($r=0.993$, $p \leq 0.05$). However it had significant negative correlation with Dry matter loss ($r= -0.927$, $p \leq 0.05$), Gruel solid loss ($r= -0.981$, $p \leq 0.05$), water uptake ratio ($r=-0.986$, $p \leq 0.05$), cooked l/b ratio($r= -0.941$, $p \leq 0.05$), Swelling capacity ($r= -0.963$, $p \leq 0.05$) and swelling index ($r= -0.975$, $p \leq 0.05$). The bulk density had significant positive correlation with dry matter loss ($r= 0.963$, $p \leq 0.05$) and cooking time($r=0.980$, $p \leq 0.05$). However it had significant negative correlation with Gruel solid loss ($r= -0.999$, $p \leq 0.05$), water uptake ratio ($r=-0.996$, $p \leq$

0.05), cooked l/b ratio(r= -0.988, $p \leq 0.05$), swelling capacity (r= -0.990, $p \leq 0.05$) and swelling index (r= -0.999, $p \leq 0.05$). The dry matter loss had significant positive correlation with Gruel solid loss (r= 0.968, $p \leq 0.05$), water uptake ratio (r=0.971, $p \leq 0.05$), cooked l/b ratio(r= 0.986, $p \leq 0.05$), swelling capacity (r= 0.986, $p \leq 0.05$) and swelling index (r= 0.968, $p \leq 0.05$). However it had significant negative correlation with cooking time(r=-0.906, $p \leq 0.05$). The cooking time had significant negative correlation with Gruel solid loss (r= - 0.980, $p \leq 0.05$), water uptake ratio (r=-0.980, $p \leq 0.05$), cooked l/b ratio(r= -0.938, $p \leq 0.05$), swelling capacity (r= -0.953, $p \leq 0.05$) and swelling index (r= -0.976, $p \leq 0.05$). The gruel solid loss had significant positive correlation with water uptake ratio (r=0.999, $p \leq 0.05$), cooked l/b ratio(r= 0.988, $p \leq 0.05$), swelling capacity (r= 0.993, $p \leq 0.05$) and swelling index (r= 0.999, $p \leq 0.05$).The water uptake ratio had significant positive correlation with cooked l/b ratio(r= 0.984, $p \leq 0.05$), swelling capacity (r= 0.994, $p \leq 0.05$) and swelling index (r= 0.990, $p \leq 0.05$).The cooked l/b ratio had significant positive correlation with swelling capacity (r= 0.993, $p \leq 0.05$), and swelling index (r= 0.990, $p \leq 0.05$).The swelling capacity had significant positive correlation with swelling index (r= 0.994, $p \leq 0.05$).

3.3. Multivariate analysis

In our study, the PCA was applied to achieve a reduction of original data matrix while retaining the maximum amount of variability present in data. The factor loading obtained for the first three components (PCs) and the percentage of variance along with cumulative variance is shown in Table 3. The first two principal components accounted for 98.74 % of the variance in the GNG 469 chick pea samples analyzed. The first and second principal components (PC1, and PC2) explained 97.72 %, and 2.04 % of the variance, respectively (Table 4). According to loading matrix (Table 4), it was observed that 65.72% variability explained by PC1 was positively correlated with variables viz. L*, b*, bulk density and cooking time located on right side and negatively correlated with a*, dry matter loss, gruel solid loss, water uptake ratio, cooked l/b ratio, swelling capacity and swelling index positioned on left side (Fig. 1). Figure 1 also illustrated that L* positioned on its upright while as b*, bulk density, and cooking time positioned on its upright. The second component (PC2=2.04 %) was positively correlated with a*, b*, bulk density, dry matter loss, cooking time, water uptake ratio, cooked l/b ratio, and swelling capacity which could be interpreted as an indicator of the good quality of chick pea characteristics.

IV.CONCLUSION

The analysed GNG 469 Chick pea Seed Cultivar revealed that sprouting significantly affects all the physical and cooking properties. Application of multivariate techniques confirmed the validity of physical and cooking properties as a analysis tool for classification and characterization of GNG 469 Chick pea Seed Cultivar. PCA revealed 97.72% of the variance with the first three principal components with L*, b*, cooking time and bulk density dominating variables. Loading data analysis proved to be an effective tool which analyse all the physical and cooking properties 100% correctly.

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Table 1. Effect of Germination period on Physical and Cooking properties of GNG 469 Chick pea seed cultivar.

Germination (hr)	L*	a*	b*	Bulk density (g/ml)	Dry matter loss (%)	Cooking time (min.)	Gruel solid loss (%)	Water uptake ratio	Cooked l/b ratio	Swelling capacity (ml/seed)	Swelling index
0	38.40	2.89	26.85	0.83	0	77.15	11.97	2.35	1.16	0.15	1.35
12	32.67	4.46	18.91	0.79	1.03	58.52	13.12	2.50	1.18	0.19	1.42
24	27.93	5.15	14.85	0.74	1.46	41.50	14.26	2.61	1.21	0.22	1.50
36	24.17	5.87	12.18	0.72	2.59	37.19	14.83	2.68	1.23	0.24	1.53
48	19.87	6.88	10.60	0.69	3.72	33.47	15.61	2.77	1.26	0.28	1.59
Mean	**28.60**	**5.59**	**16.67**	**0.75**	**1.76**	**49.56**	**13.95**	**2.58**	**1.20**	**0.21**	**1.47**
CD	**1.08**	**0.47**	**1.05**	**0.03**	**0.30**	**4.20**	**0.64**	**0.05**	**0.012**	**0.013**	**0.024**
SE (m)	**0.35**	**0.15**	**0.34**	**0.009**	**0.09**	**1.38**	**0.21**	**0.018**	**0.004**	**0.004**	**0.008**

Table 2. Pearson's correlation coefficient between cooking and physical properties of GNG 469 Chick pea seed Cultivar

	L*	a*	b*	Bulk Density	Dry Matter Loss	Cooking Time	Gruel Solid Loss	Water uptake Ratio	Cooked l/b ratio	Swelling Capacity
a*	-0.995 0.000									
b*	0.974 0.005	-0.979 0.004								
Bulk Density	0.996 0.000	-0.986 0.000	0.977 0.004							
Dry Matter Loss	-0.983 0.003	0.980 0.003	-0927 0.023	0.963 0.009						
Cooking Time	0.967 0.007	-0.964 0.008	0.993 0.001	0.980 0.003	-0.906 0.034					
Gruel Solid Loss	-0.998 0.000	0.991 0.001	-0.981 0.003	-0.999 0.000	0.968 0.007	-0.980 0.003				
Water uptake Ratio	-0.993 0.001	0.996 0.000	-0.986 0.002	-0.996 0.000	0.971 0.006	-0.980 0.003	0.999 0.000			
Cooked l/b ratio	-0.998 0.000	0.980 0.003	-0.941 0.017	-0.988 0.002	0.986 0.002	-0938 0.018	0.988 0.002	0.984 0.002		
Swelling Capacity	-0.997 0.000	0.995 0.000	-0.963 0.009	-0.990 0.001	0.986 0.002	-0.953 0.012	0.993 0.001	0.994 0.001	0.993 0.001	
Swelling Index	-0.997 0.000	0.989 0.001	-0.975 0.005	-0.990 0.000	0.968 0.007	-0.976 0.004	0.999 0.000	0.997 0.000	0.990 0.001	0.994 0.001

Table3. Principle component analysis

	Total variance explained		
PC	Eigen value	% of variance	Cumulative %
1	10.74	97.72	97.72
2	0.224	2.041	99.76
3	0.026	0.237	100

Table 4.Principal component analysis.Loading of the first two components.

Factor loading	PC1	PC2
L*	0.305	-0.085
A*	-0.302	0.313
b*	0.301	0.253
Bulk density	0.304	0.200
Dry matter loss	-0.294	0.534
Cooking time	0.290	0.643
Gruel solid loss	-0.305	-0.106
Water uptake ratio	-0.305	0.010
Cooked l/b ratio	-0.305	0.107
Swelling capacity	-0.302	0.244
Swelling index	-0.304	-0.102

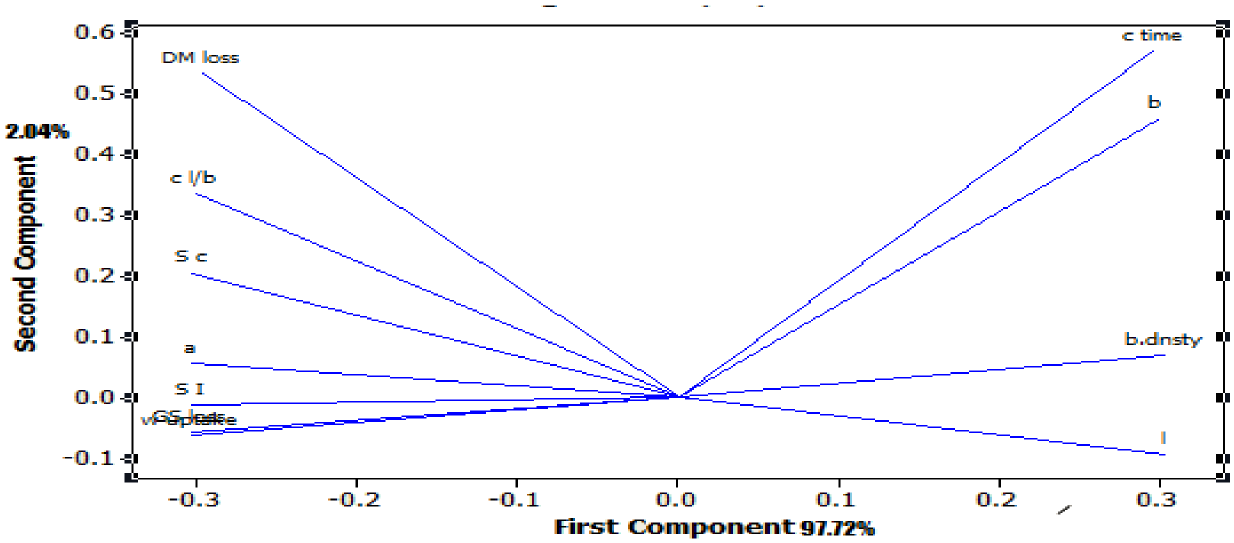

Figure1. Projections of the variables on the factor plane for the physical and cooking properties of GNG 469 chick pea sample