Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.7472

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **7 (3):** 181-188 (2019)

International Journal of Pure & Applied Bioscience

Research Article

OPEN ACCESS

Effect of Soaking Time on Sprouting and Rheological Properties of Green Gram

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Received: 5.04.2019 | Revised: 28.04.2019 | Accepted: 07.05.2019

ABSTRACT

Present study indicates the effect of soaking time on the sprouting characteristics of green gram (Vigna radiate L). 3h, 6h and 9h soaking time showed increased sprouting percentage as 88%, 97% and 97.5% in 22h, 20 h and 20 h respectively. Hydration rate study showed that final moisture content of 6h and 9h soaked sample was higher i.e. 53.69% and 55.42% than the 3h soaked sample (41.66%). Sufficient imbibition of water was noticed in 6h and 9h soaking time intervals responsible for the highest sprouting rate. Increased sprouting rate in 6h and 9h soaking time showed the enhancement in the nutritional and pasting properties of green gram malt than the raw green gram flour. 6h and 9h soaked and malted sample showed significantly higher protein (23.86%, 24.13%) and fibre (3.66%, 3.68%) while fat content was observed to be significantly decreased than the raw green gram flour and 3 h soaked and malted green gram sample. Pasting properties showed increasing trend of peak, trough, final, setback and breakdown viscosities in 3h<6h<9h soaked and malted samples. Pasting temperature was highest (74.39°C) in 9 h soaked and malted samples. The present study will be beneficial for the food industry to produce the good quality malt by applying the 6h and 9h soaking time for spouting process.

Key words: *Green gram; Malting; Protein; Soaking time; Rheology; Hydration rate.*

INTRODUCTION

Pulses are the major source of protein of the human dietary system and cultivated under variety of growing conditions. They are globally popular as they constitute essential source of dietary calories[8]. They are majorly consumed as staple foods specifically in Asian dietaries[14]. Among these Green gram (*Vigna radiata* L.) is consider as principal pulse crop which is more common in Southeast Asia, Central Africa, the warmer parts of China and the United States[20]. Green gram seeds are more digestible than other pulses due to lower content of raffinose, stachyose and oligosaccharides associated with the flatulence and intestinal disorders[15].

Cite this article: Dattatray, T.R., Monica, O., Surendra Babu, A. and Jaganmohan, R., Effect of Soaking Time on Sprouting and Rheological Properties of Green Gram, *Int. J. Pure App. Biosci.* **7(3):** 181-188 (2019). doi: http://dx.doi.org/10.18782/2320-7051.7472

Sprouting greatly influence the nutritional quality by enhancing bioavailability of nutrients as well as improving the digestibility and usage of nutrients[13]. Improvement in the nutritional and medicinal qualities in the sprouting process is mainly because of activation of biosynthetic enzymes during soaking i.e. initial stages of sprouting[17]. Sprouting followed by drying (controlled germination) resulted in the malt production, which helps to convert the sprouts into more digestible form.

Imbibition of water during soaking plays an important role during sprouting. Water uptake process majorly divided into three phases first phase imbibition of water during soaking, second is activation of enzymes and third is growth phase so the study of hydration rate plays an important role to study the efficient sprouting process of green gram[7]. If soaking time was not sufficient proper imbibition of water will not occur resulting in delayed sprouting process or it may not activates the hydrolytic enzymes responsible for further sprout growth. By considering this, there is need to optimise the soaking time for maximum sprouting rate. Also the maximum sprouting will leads to add the nutritional value by increasing the protein and fibre content in the final malt and finally improves the quality of green gram malt. Evaluation of the sufficient soaking time will leads to know the process time for entire malting process and will become helpful for the food industry to develop a variety of nutritionally enriched value added products from the green gram malt.

Present study aimed to study the effect of three different (3h, 6h and 9h) soaking time on the hydration rate and sprouting rate of green gram and also to help the food industry by giving an general idea about the processing time of malt and nutritional and rheological properties for malt as affected by the different soaking time.

MATERIAL AND METHODS

2.1 Materials

Green gram sample of variety vamban 2 was collected from the National Pulse Research Centre (NPRC), TNAU, Tamil Nadu, India. All the chemicals and regents are purchased from sigma-Aldrich.

2.2 Preparation of samples

Green gram sample of Vamban-2 variety was collected and cleaned properly by removing forign particals, broken and dust. Sample seeds of 100no.was taken and initial weight was taken. Weighed and counted seeds were subjected to different for soaking time (3h, 6h, 9h) as per the given below. Proximate composition of green gram as measured by AOAC (2000) was moisture 10.42%, protein 21.62%, fat 2.40%, carbohydrate 58.93%, crude fibre 3.42%, and, ash 3.84%.

2.3 Different soaking time treatments

Three sets of Pre-weighed green gram samples (100 no.) were made ready for subjecting to different soaking time. Soaking was carried out in distilled water. Pre-weighed counted green gram seeds were soaked for 3 different time interval i.e. 3h, 6h and 9h. After particular soaking time interval the soaked seeds were subjected to sprouting by transferring it to the Petri dishes lined with wet filter paper in a humidifier (27^{o}C and 70% RH).

2.4 Hydration study for different soaking time intervals

For hydration rate study, pre-weighed 10 g of green gram were soaked in beaker containing 4L of distilled water (for avoiding the water to be limiting in the process) at 27± 1^{o}c for 9h to know the hydration rate for 3h, 6h, and 9h period. During the soaking process to see the hydration rate, the grains were periodically drained and their moisture content was obtained by the mass balance using the initial moisture content of green gram[10]. Then the grains were soaked again to continue the process of soaking. The soaked grains were weighed for every 30 min during 3h, 6h and 9h soaking time. The hydration process was performed at constant temperature using a water bath at 27^{o}c and in triplicate. Graph were plot for the moisture content Vs soaking time.

2.5 Determination of sprouting percentage

Sprouting percentage of green gram samples subjected to different soaking time intervals

were calculated by following method. The number of seeds sprouted for different soaking time treatment was recorded at 2 h interval till the maximum seeds got sprouted. Sprouting percentage[9] was determined using the following equation.

$$\text{Sprouting percentage (\%)} = \frac{\text{Total number of seeds sprouted}}{\text{Total numberof seeds soaked}} \text{ x } 100$$

2.6 Drying of sprouted green gram seeds

Seeds subjected to different soaking time were sprouted and further dried by tray drying techniques to convert it into malt. A 100 g of sprouted green gram sample was subjected to tray drying at 60^{o}C.

2.7 Preparation of green gram malt

Green gram malt was prepared according to following procedure (Fig 1). Green gram sample was taken and were subjected to different soaking time intervals and sprouted (27^{o}C & 70% RH). Sprouted green gram was dried by conventional tray drying techniques. After drying it was milled to obtained fine powdered green gram malt.

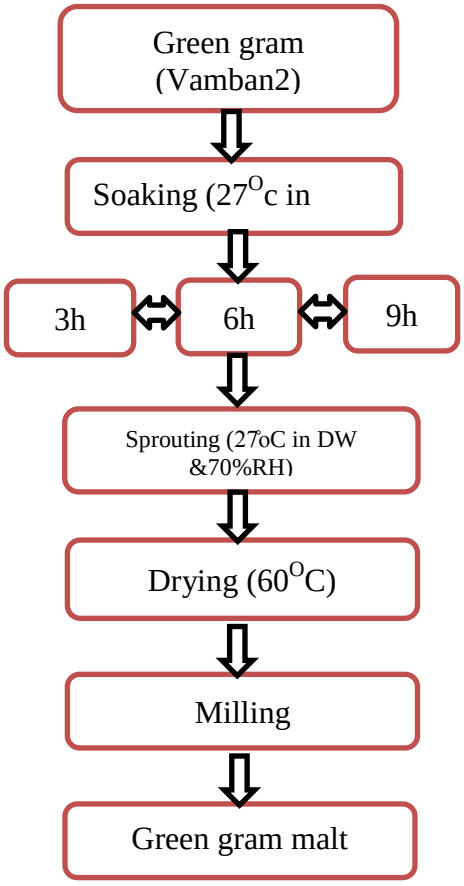

Fig. 1: Preparation of green gram malt with different soaking time

2.8 Chemical analysis of green gram malt

Chemical analysis of green gram malt including moisture, crude protein, ash, crude fat and crude fibre were determined by standard AOAC 2000 method. Carbohydrates content of green gram sample were calculated by differential method (100- moisture, protein, fat, ash, and crude fibre)[3].

2.9 Pasting properties of green gram malt

Pasting profile of green gram malt which was sprouted with different soaking time was determined using a Rapid Visco Analyser (New port Scientific (RVA 190 4 SA), Australia). Malt suspension was taken for analysing viscosity profile. Samples were held at 50^{o}C for one min, further heated from 50^{o}C

to 95°C at 12.16°C/min, held at 95°C for 2.30 min, cooled from 95°C to 50°C at 11.84°C/min, and held at 50°C for 2 min according to the Standard profile. All the parameters of pasting properties were recorded using RVA.

2.10 Statistical analysis

For each soaking time variation pre-treatment mean value and standard deviation of the triplicate values were calculated. The sprouting percentage data of different soaking time was analysed by using two-way ANOVA. Data of Proximate analysis, Pasting properties were analysed by one-way Analysis of Variance (ANOVA) using SPSS program (Statistical Package for Social Science) version14.0 (SPSS Inc., Illinois, USA). Further comparison of mean values was done by using LSD at $p < 0.05$.

RESULTS AND DISCUSSION

3.1 Effect of soaking time on the hydration rate of green gram

Hydration rate of green gram at various soaking time interval was studied. Fig 2 showed that rate of water absorption was initially high followed by slower absorption in later stages. The diffusion of water into the seeds mainly because of concentration difference between soaking medium and green gram seeds also the researchers revealed that mass transfer mechanism is influenced by the permeability characteristics of seed husk, water temperature and food colloids component properties[12].

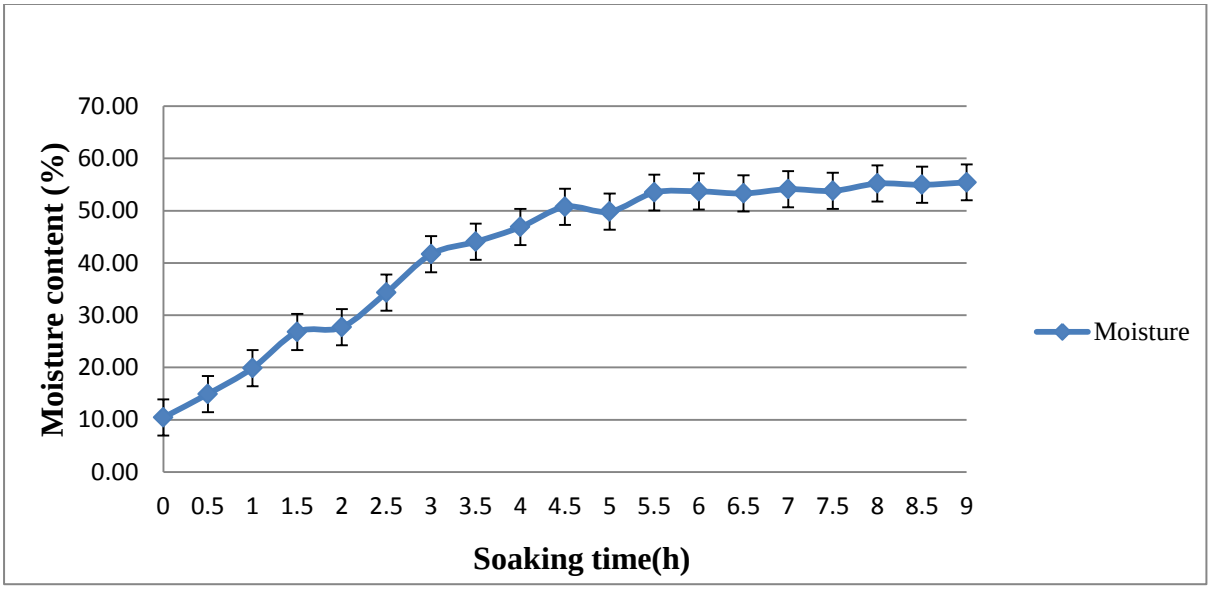

Fig. 2: Effect of soaking time on the hydration rate of green gram

Fig 2 indicates that hydration rate increased rapidly in first 3 h later within 3 to 6 h rate became comparatively slower and further no significant increase was observed during 6 to 9 h soaking time. This indicated that as soaking time increases the moisture content of sample was observed to increase. Moisture content of green gram at the end of 3 h, 6h and 9h soaking period was found to be 41.66%, 53.69% and 55.42% indicated that moisture content was higher in 6h and 9h soaking time which will helps to increase the sprouting rate by using above soaking time.

3.2 Effect of soaking time on sprouting percentage

Fig 3 indicates the sprouting rate of green gram which is subjected to different soaking time. It indicates that sample soaked for 6h (97%) and 9 h (97.5%) showed the highest sprouting percentage in 20h of sprouting while sample soaked for 3 h showed the 88% of sprouting in 22 h. This helps to prove the effect of soaking time on sprouting rate. Increase in the sprouting rate could be the effect of sufficient hydration of green gram during soaking time of 6h and 9h as during

hydration metabolic activity of resting seeds increases which will leads to complex metabolic changes resulting in onset of sprouting process[6]. Insufficient imbibition of water during 3h soaking resulted in the less sprouting rate of the sample. Sufficient soaking time followed by maximum sprouting will help to enhance the nutritional quality of green gam as it helps to reduce the anti-nutritional factors this results are correlated with the study conducted by Chitra *et al*.[2] who stated the 60% reduction in phytic acid content in chickpea and pigeon pea and over 40% reduction in green gram was observed on germination. This proved the importance of soaking and sprouting of green gram.

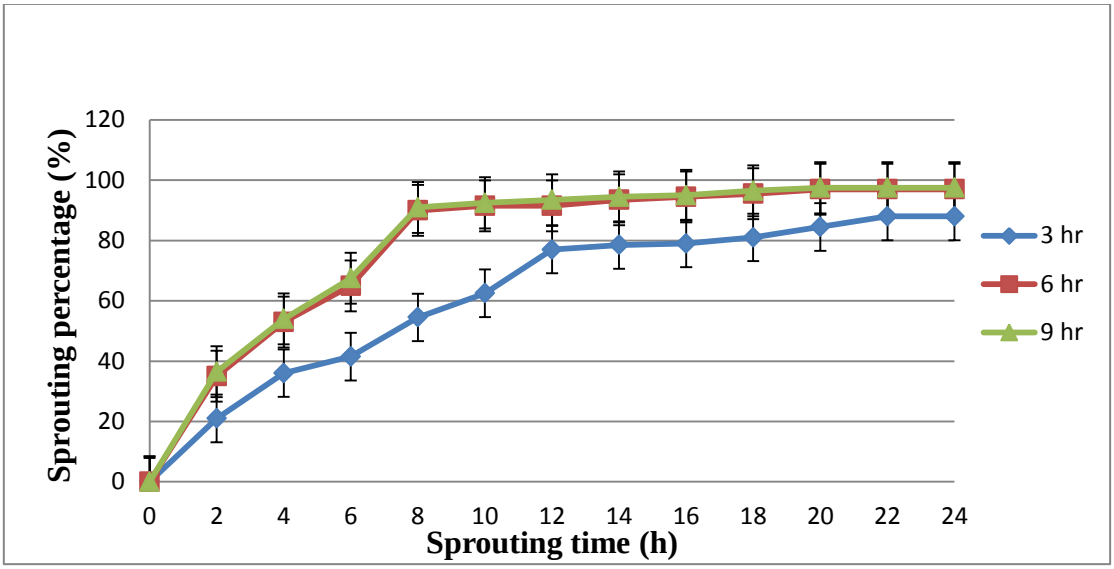

Fig. 3: Sprouting rate of green gram soaked for different time intervals

Two-way ANOVA revealed that the Soaking time and sprouting time significantly affected the sprouting percentage. The interaction of soaking time treatment and sprouting time also showed significant effect on the sprouting percentage of green gram.

3.3 Proximate composition of green gram malt sprouted by different soaking time

Table 1 indicates the proximate composition of green gram malt which is sprouted with different soaking time. Moisture content of raw green gram flour is 10.42% which is significantly varying from the entire green gram malt samples. There is no significant difference observed in the moisture content of malt samples prepared by 3h, 6h and 9h soaking period followed by sprouting and drying.

Table 1: Proximate composition of green gram malt

Proximate composition	Raw green gram flour	3h soaked and malted	6h soaked and malted	9h soaked and malted
Moisture	10.42±0.64a	9.97±0.01ab	9.12±0.01b	9.14±0.02b
Protein	21.62±0.43a	22.96±0.03b	23.86±0.01c	24.13±0.01c
Fat	2.40±0.01a	2.39±0.03a	2.37±0.06a	2.10±0.01b
Fibre	3.42±0.06a	3.45±0.01b	3.66±0.02c	3.68±0.01c
Ash	3.84±0.08a	3.34±0.01b	3.44±0.02cb	3.54±0.01c
Carbohydrates	58.93±0.22a	57.95±0.04b	57.57±0.10c	57.42±0.02c

Values are mean ± SD (n = 3) Lower case letters among the raw green gram flour and soaking time treatments indicates the significance difference between the samples at $p<0.05$.

Protein content of malted samples were in the range of 22.96% to 24.13% and were significantly higher than the raw unsprouted green gram flour which was 21.62. Sprouting and malting is majorly responsible for the increased protein content of malt sample. Effect of sprouting during malting also noticed by the Murugkar *et al*; 2013 who stated that crude protein content of sprout mixes were higher (22.5 to 24.8 %) than the unsprouted mixes. The increase in protein content of malt sample could be due to an increase in the free amino acids and peptides[1] and also contributed by the increment in the non-protein nitrogeneous constituent during sprouting[18]. Malt samples of 9h soaking showed the highest protein content than the rest samples as 9h soaked and sprouted samples showed the maximum sprouting percentage which was responsible for the higher protein content.

Fat content of raw green gram flour and malt sample were ranges between 2.10% to 2.40%. Reduction in the fat content was observed in the malt sample majorly contributed by the sprouting during malting process. Fat content was observed to be decreased (2.10%) in the 9h soaked malt sample this may be because of total solid loss during 9h soaking prior to sprouting and malting[21] also this decrease on sprouting and malting mainly caused by their utilization as energy source in the sprouting process. This results are on the par with the finding by the vanderstoep in 1981on the germinated green gram and lentils.

Fibre content of raw green gram flour was 3.42% and observed to be increased in the malted samples. Fibre content of malted sample showed increasing trend as 9h (3.68%) > 6h (3.66%) > 3h (3.45%). Ash content of raw green gram flour was significantly higher (3.84%) than the all malt samples. Similarly carbohydrate content was found to be higher (58.93%) in the raw green gram flour followed by 3h, 6h and 9h soaked malted samples as 57.95%, 57.57% and 57.42% respectively. Decreasing trend of carbohydrate content was observed due to sprouting process. The significantly lowered ash content might be due to leaching out of some water sensitive soluble minerals during soaking. Decrease in total carbohydrate content may be attributed to the enzymatic hydrolysis of the carbohydrates to simpler sugars during sprouting[5].

3.4 Pasting properties of green gram malt sprouted with different soaking time

Table 2: Pasting properties of green gram malt sprouted with different soaking time

Pasting properties	Raw green gram flour	3h soaked and malted	6h soaked and malted	9hsoaked and malted
Peak Viscosity(cP)	321.40±45.96a	792.50±4.95b	830.55±16.90cb	900.50±16.26c
Trough viscosity(Cp)	256.40±33.38a	554.00±8.49b	531.90±7.35cb	671.50±10.61d
Breakdown(cP)	85.52±12.54a	223.00±15.56b	298.60±24.18c	488.00±14.14d
Final viscosity(cP)	496.25±63.57a	840.00±8.49b	805.75±11.95cb	946.00±16.97d
Setback(cP)	239.90±30.12a	277.00±14.14a	273.85±4.60a	358.50±3.54b
Peak Time(min)	7.23±0.01a	6.17±0.08b	6.61±0.02c	6.76±0.04d
Pasting Temperature(^{o}c)	72.63±0.66a	73.20±0.20ab	73.63±0.05bc	74.39±0.07c

Values are mean ± SD (n = 3) Lower case letters among the raw green gram flour and soaking time treatments indicates the significance difference between the samples at $p<0.05$.

Table 2 represents the pasting properties of green gram malt sprouted with the different soaking time. It indicates that 9h soaked and malted sample showed the higher peak (900.50cP), trough (671.50cP), final (946.00cP) and setback (358.50cP) viscosity than the raw green gram flour and remaining malt samples. While among the malt samples there is increasing trend of peak, trough, final and setback viscosity in 9h>6h>3h samples. Peak viscosity indicates ability of starches to swell before their physical break down[4]. So increased peak viscosity in 9h soaked and malted samples proved that increased

sprouting will helps to increase the ability of starch to swell before breakdown. Increase in the final viscosity of the 9h soaked and 20h sprouted and malted sample indicated their ability to form the viscous paste.

Breakdown viscosity indicates the ease with which the swollen granules disintegrate during heating and shearing[16]. Breakdown viscosity of raw green gram flour was found to be lower (85.52Cp) while Among malt samples 9 h soaked and malted sample showed the highest breakdown viscosity (488cP). Raw green gram flour showed the highest peak time (7.23min) while 3h soaked malt sample showed the lowest peak time (6.17min). Pasting temperature is the measure of minimum temperature required to cook the sample[22]. Lower pasting temperature (72.63^{o}C) was observed in the raw green gram flour while pasting temperature of 3hr, 6hr and 9hr soaked and malted samples showed increasing trend 73.20^{o}C, 73.63^{o}C and 74.39^{o}C respectively, showed that sprouting of green gram was mainly responsible for the increased pasting temperature.

CONCLUSION

Sprouting of green gram gets affected by the soaking time variation. 9h and 6h soaking time followed by sprouting showed the positive effect by showing highest sprouting percentage i.e.97.5% and 97% in 20 h of sprouting compared to 3 h soaking time followed by sprouting. Effect of soaking time on the sprouting majorly contributed by the imbibition of the water during soaking time as indicated by the hydration rate study. Sufficient hydration of green gram was carried out in 6h and 9h of soaking time showed the highest sprouting rate than the 3h soaked sample. Increased sprouting rate also showed the positive correlation with the nutritional and pasting properties of green gram malt. 9h and 6h soaked sample showed significant increase in the protein, fibre content in the green gram malt while fat content was observed to be significantly decreased. Pasting properties got improved as sprouting increases. This indicated that the 6h and 9h soaking time followed by sprouting will give the good quality malt which will be helpful for the flour industry.

Acknowledgment

First author would like to acknowledge Indian Institute of Food Processing Technology, Thanjavur for the support and resources extended for the present research work.

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