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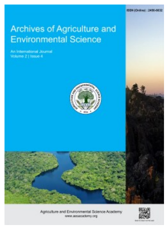

ORIGINAL RESEARCH ARTICLE

Effect of water spraying time on nutritional quality of mung bean sprouts

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ABSTRACT

The study evaluates the effect of spraying time on growth and nutritional quality of sprouts from two mung bean varieties. The experiment was conducted using a Completely Randomized Design (CRD) with four replications. This study used two factors experiment (variety and spraying time) comprised three treatments for the two mung bean varieties, BARI Muge Bean 2 and BARI Muge Bean 5. The water spraying times were categorized T_1(15 seconds), T_2(18 seconds) and T_3(20 seconds). Data were collected in the Plant Biotechnology Lab and Post Harvest Lab, PSTU. Significant variations were observed in the result; the highest sprout shoot length (6.05 cm) and root length (1.10 cm) were recorded in T_3. Additionally, the highest fresh sprout weight was with T_3 measuring (25.90 g). Regarding chemical parameters, the highest values were noted as follows: pH in T_3(6.49), Total Soluble Solids (TSS) in T_1 (7.22%,), vitamin C in T_3(13.20 g), anthocyanin in T_3 (77.50 mg), antioxidants content in T_3 (126.40 mg), phenol content in T_3(146.72 mg), carbohydrate in T_3 (6.08 g), total sugar in T_1(4.22 g) and reducing sugar in T_1(2.17 g). In conclusion, the combination of longer spraying time and the BARI Mung Bean 5 variety produced higher quality sprouts and enhanced biochemical content, with the exception of pH, TSS, and sugar levels. Future research should explore additional factors affecting sprout quality.

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INTRODUCTION

The mung bean (*Vigna radiata*), is a plant species in the Leguminosae family and the seeds of Mung bean contain dietary fibers, protein, minerals, vitamins, and bioactive agents that exhibit various health benefits (Uppalwar *et al*., 2020). Mung beans are widely cultivated across southern Asia, including countries such as India, Pakistan, Bangladesh, Sri Lanka, Thailand, Laos, Taiwan, South China, and Malaysia (Verma, *et al*., 2017). As the demand for food continues to escalate due to a growing population, alternative agricultural practices have become a priority. These practices aim to meet the increasing food needs while aligning with the renewed interest in natural and local food production (Dupré *et al*., 2020). Aquaponic and sprouting systems are recognized as sustainable agricultural practices that address both economic and resource challenges associated with traditional food production. Specifically, aquaponics has emerged as a sustainable alternative to conventional agriculture in Egypt, yielding high-quality, organic food while conserving up to 85% more water and creating new entrepreneurial opportunities (Hisham El-Essawy *et al*., 2019). Sprouting is a green food engineering method to produce and accumulate bioactive compounds in grains, which may have potential beneficial functions against diabetes and cancer (Gan *et al.*, 2019). Sprouts of selected pulses provide protein, fiber, vitamins, and minerals, such as iron, zinc, folate, and magnesium (Khyade & Jagtap, 2016). Mung bean sprouts contain abundant nutrients with biological activities such as antioxidant, antimicrobial, anti-inflammatory, antidiabetic, antihypertensive, and antitumor effects (Tang *et al.*, 2014). Bean sprouts can be produced all year round because combining light and low relative humidity in indoor mung bean sprout production increases antioxidant content, making them a nutritious food supplement (Amitrano *et al.*, 2020). The optimum germination time for mung bean sprouts is 3-5 days, when total bioactive compound content and antioxidant activities reach their peak values (Xue *et al.*, 2016). The maximum nutritional value of bean sprouts is achieved on the third day after germination, as the germination process activates nutrient content for human consumption (Lorenza, R, *et al.*, 2023). Sprouts are functional foods with health-regulating or disease prevention qualities, including antioxidant properties, phytochemicals, and various health-promoting benefits (Waliat *et al.*, 2023). The amount of water and water frequency are significant factors in the growth of mung bean sprouts. Watering conditions significantly affect the biochemical and physical traits of mung bean sprouts, with watering interval significantly affecting root and lateral root development (Lim, *et al.*, 2022). Given that sprouting is a cost effective and efficient method for enhancing nutritional quality, it is vital to explore how water spraying time affects the quality of mung bean sprouts. Additionally, as a new functional food, sprots can contribute nutrition of local populations. Therefore, it is essential to investigate the effects of water spraying timing on the quality of mung bean sprouts. To address this issue, research has been conducted to determine the optimal amount of water and spraying time for the production of mung bean sprouts. The study also aim to assess their physicochemical qualities, including sprout weight, shoot and root length, total anthocyanin and carotenoids, ascorbic acids, antioxidant and phenolic contents and sugar contents. The goal of the study is to identify the best sprout quality among varietal variation.

MATERIALS AND METHODS

Experimental design

The study was conducted in the Plant Biotechnology and Post Harvest Laboratory at the department of Horticulture, Patuakhali Science and Technology University, Bangladesh. The experiment consisted of two factors. Factor A comprised two mung bean varieties : V_1 (BARI Mung-2) and V_2 (BARI Mung-5). Factor B involved different spraying times: T_1 (15 seconds per hour), T_2 (18 seconds per hour), T_3 (20 seconds per hour). Samples of mung bean varieties BARI 2 and BARI 5 were collected from the PSTU khamar vhabon. Mungbean seeds were placed in a bean sprouting chamber to observe the germination rate. Watering was maintained daily at a specific rate. After 5 days, the seed splits, and a soft whitish root emerged. Once germination was complete, the raw sprouted beans were collected. Finally, both physical and chemical characteristics of the sprouted beans were analyzed. The research was conducted from August 2017 to May 2018.In this study spraying time was adjusted as a physical parameter. T_1 indicates a 30 min water spray over 5 days. Another T_2 indicates a 36 min water spray and T_3 indicates a 40-min water spray over the same period. Thus, minimum Spraying time was employed in T_1 while maximum spraying was used in T_3. Water quantity was also adjusted as a physical parameter. T_1 corresponds to a total of 45 ml of water spray over 5 days, T_2 indicates 54 ml, and T_3 indicates 60 ml. Consequently, the minimum amount of water is sprayed in T_1, while the maximum is applied in T_3.

Sprout parameters estimation

Sprout shoot and root length were determined with a scale (in cm) after fresh sprouts were collected. Fresh sprout weight was collected and then it was weighted with an electric balance. The ascorbic acid content was determined according to Ranganna (2010). Total anthocyanin and carotenoids of the bean sprouts were determined by the method described by Sims and Gamon (2002). The total antioxidant content was calculated using a calibration curve: y = 256.11x -12.645, R2 = 0.9974, where x represents absorbance (695) and y denotes the concentration of gallic acid. The amount of total phenolic content was determined by the established method described by Chanda & Dave *et al.* (2009). Sugar content was measured according to the method outlined by Lane and Eynon (2019).

Statistical analysis

Data from all parameters were statistically analyzed using the MSTAT-C data analysis program. The recorded data were evaluated using analysis of variance (ANOVA), and means were compared using Duncan's Multiple Range Test (DMRT) at a 1% level of probability, as described by Gomez & Gomez (1984).

RESULTS AND DISCUSSION

Fresh sprout weight

In this study, fresh sprout weight was measured as a key physical parameter. The fresh sprout weight was determined using a scale. Treatment 1 exhibited the lowest fresh sprout weight at 21.625 g, while Treatment 3 demonstrated the highest fresh sprout weight at 25.900 g. Thus, the results indicate that the greatest fresh sprout weight was observed in Treatment 3, whereas the lowest was recorded in Treatment 1.

Sprout shoot and root length

The results for sprout shoot length revealed that Treatment 1 had the lowest growth, measuring 5.48 cm. Conversely, Treatment 3 exhibited the highest shoot length, measuring 6.05 cm. The longest shoot length was recorded in Treatment 3, while Treatment 1 showed the shortest. Regarding root length, Treatment 3 exhibited the highest root growth, while Treatment 1 showed the lowest root length. These findings suggest a positive correlation between treatment conditions and root development, with Treatment 3 yielding superior outcomes.

Anthocyanin

The result of the research showed that the highest anthocyanin content was observed at the last level of water treatment, measuring (77.506). Anthocyanin contents were same for the first two water treatments (T_1 and T_2), which was (76.886) and it was increased for the T_3 with increasing amount of water spray in the Mungbean at 20 sec per hour water treatment over 5 days. Similar results were concluded by (Cracker *et al.*, 1973) on some pulse crop and seedlings. Moreover, Anthocyanin content was higher in V_2(77.806) and lower in V_1(76.346). Combined effect of spraying time and mung bean sprouts for anthocyanin, the highest value was found in the combination of T_3V_2, measuring (78.942) and the lowest value was found in the combination of T_1V_1 which was (75.670). After 5 day the highest value was found in the combination of T_3V_2. It had been shown that irrigation water and storage condition increase the anthocyanin and other polyphenolic compounds (Kyraleou *et al.*, 2016).

Total carotenoids

Analysis of Mungbean sprouting revealed that the highest amount of carotenoids were found at the first two levels of water treatment (T_1 and T_2), measuring (0.040) and it was decreased for the T_3 with increasing amount of water spray in the Mung bean at 20 sec per hour water treatment over 5 days. Furthermore, higher value of carotenoid was found in V_2 (0.042) and lower value found in V_1(0.037). The highest value was observed in the combination of T_2V_2, measuring (0.044) and the lowest value was found in the combination of T_3V_1 which was (0.036). After 5 day the highest value was exhibited in the combination of T_2V_2.

Table 1. Combined effect of treatment and variety of mung bean sprouts on total sugar, Vitamin C and carbohydrate contents.

Treatment × variety	Total sugar (%)	Vitamin C	Carbohydrate
T_1V_1	4.3350c	12.60b	5.930b
T_1V_2	4.250ab	13.55a	6.170a
T_2V_1	4.225c	12.62b	5.940b
T_2V_2	4.325a	13.60a	6.222a
T_3V_1	4.125bc	12.70b	5.932b
T_3V_2	4.120c	13.70a	5.932b
Level of Significance	**	**	**

NS= Non Significant, ** Significant at 1% level of probability.

Table 2. Combined effect of treatment and variety of mung bean sprouts on anthocyanin, carotenoid, antioxidant and phenol content.

Treatment × variety	Anthocyanin	Carotenoid	Antioxidant	Phenol
T_1V_1	75.670c	0.038	122.902b	131.260c
T_1V_2	78.103b	0.043	128.012ab	157.660a
T_2V_1	76.298bc	0.037	122.933b	134.487b
T_2V_2	77.373ab	0.044	128.915b	158.490a
T_3V_1	77.070abc	0.036	123.390b	134.347b
T_3V_2	78.942a	0.042	129.410a	159.100a
Level of Significance	*NS	NS	*	**

NS= Non Significant, * Significant at 5% level of probability, ** Significant at 1% level of probability.

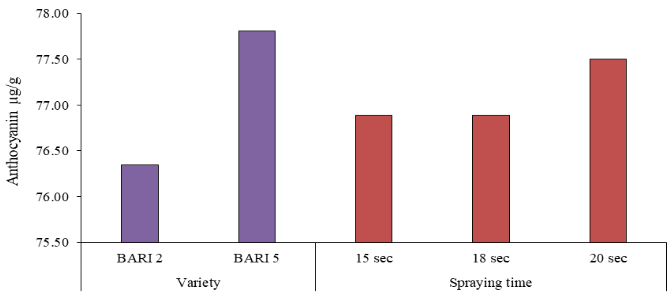

Figure 1. *Single Effect of Variety and Spraying Time on Anthocyanin Content in Mungbean Sprouts under Different Treatments. (Values of varietal bars with different letters differ significantly at 1% level of probability, analyzed by DMRT).*

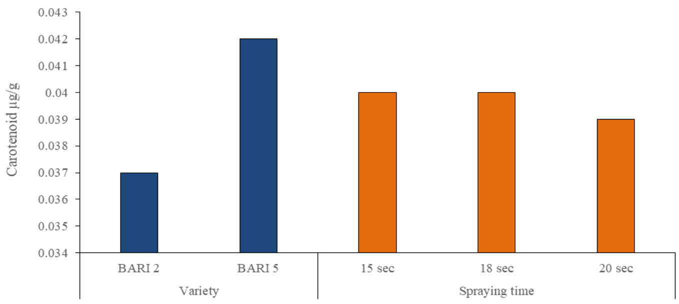

Figure 2. *Single Effect of Variety and Spraying time on Carotenoids of Mungbean Sprouts under Different Treatments .(Values of varietal bars with different letters differ significantly at the 1% level of probability, analyzed by DMRT).*

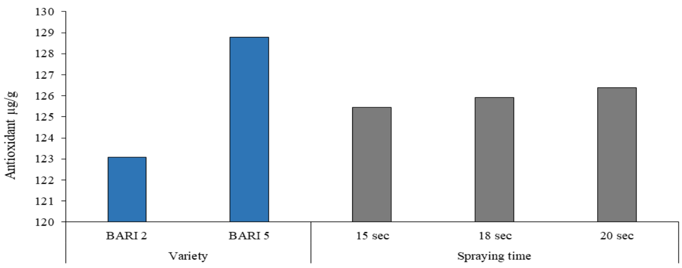

Figure 3. *Single Effect of Variety and Spraying Time on Antioxidants Content in Mungbean Sprouts under Different Treatments .(Values of varietal bars with different letters differ significantly at the 1% level of probability analyzed by DMRT).*

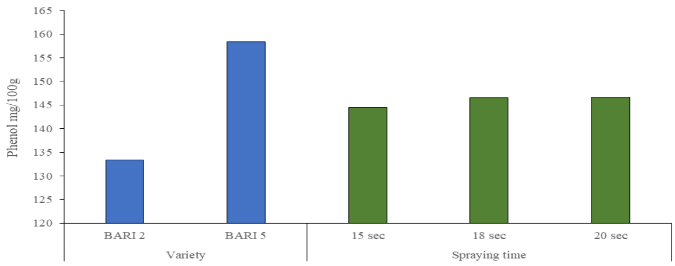

Figure 4. *Single Effect of Variety and Spraying Time on Phenol Contents in Mungbean Sprouts under Different Treatments. (Values of varietal bars with different letters differ significantly at the 1% level of probability analyzed by DMRT).*

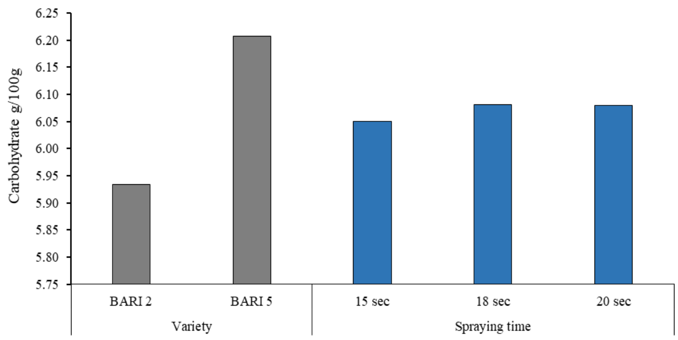

Figure 5. *Single Effect of Variety and Spraying Time on Carbohydrate Contents of Mungbean Sprouts at Different Treatments. (Values of varietal bars with different letters differ significantly at the 1% level of probability, analyzed by DMRT).*

Antioxidant

The total Antioxidant were gradually increased in the T_1 to T_2 and then T_3. The amount of total Antioxidant was (125.457) for T_1, T_2 was 125.924 and highest antioxidant was found in the T_3, measuring (126.400). It was indicated that the T_1, T_2 and T_3 treatment were not same and it was increased for the T_2 and then T_3 with the increasing amount of water spray in the Mung bean at 20sec per hour water treatment over 5 days. (Fernandez -Orozco *et al.*, 2006) was got the same result from producing sprouts. Additionally, the Antioxidant was higher in V_2 (128.779) and lower in V_1 (123.075). The highest value was found in the T_3 and V_2 that combination of T_3V_2 which was (129.410) and the lowest value was found in the combination of T_1V_1 which was (122.902). After 5 days the highest value was found in T_3V_2. (Hsu *et al.*, 2008) studied the improvement of the antioxidant activity of buckwheat sprout using trace element containing water and increasing of water.

Total phenol

The study showed that the total phenol were gradually increased in the T_1 to T_2 and then T_3. The amount of total phenol was (144.46) for T_1, T_2 was (146.489) and highest antioxidant was observed in the T_3 (146.724). It was indicated that T_1, T_2, T_3 were not same and it was increased for the T_2 and then T_3 with the increasing amount of water spray in the Mung bean at 20 sec per hour water treatment over 5 days. (Xu *et al.*, 2005) was got the same result from producing sprouts. In addition to, phenolic content was higher in V_2 (158.417) and lower in V_1 (133.365). The highest value was found in the combination of T_3V_2 and the value was (159.100)and also lowest value was found in the combination of T_1V_1 which was (131.260). After 5 day the highest value was found in T_3V_2. Sprouting a food for 48 hours can increase the phenolic content (Duhan *et al.*, 1999).

Total carbohydrate

Total carbohydrate contents were gradually increased in the treatment T_1 to T_2 and then again decreased T_3. The amount of total carbohydrate was 6.050 for T_1, T_2 was 6.081. Highest carbohydrate was observed in T_2 (6.081). It was indicated that the T_1 T_2 and T_3 treatment were not same and it was increased for the treatment 2 and then decreased in treatment 3. (Nodaa *et al.*, 2004) examined the physical and chemical properties of the partially degraded starch of wheat sprout and get the same result. Moreover, the higher value of Carbohydrate was found in the variety 2 (2.207) and lower value was found in the variety 1 (5.934). The highest value was found in the combination of T_3V_2 and the value was 6.227 and also the lowest value was found in the combination of T_1V_1 which was 5.930. After 5 day the highest value was found in T_3V_2.

Total sugar content

The result of the study observed that the content of sugar were gradually decreased in the T_1 to T_2 and then T_3. The amount of total sugar was (4.225) for T_1, T_2 was 4.175 and the lowest total sugar was found in the T_3 (4.15). The sugar content in soybean seed decreased during the sprouting process. (Shi *et al.*, 2010) found that sugar content in soybean sprout was 19.9% but decreased to 14% after 7 days of sprouting. Additionally, the higher value of Carbohydrate was found in the variety 1 (4.70) and lower value was found in the variety 2 (4.06).Combined effect of spraying time and mung bean sprouts for total sugar content during chemical analysis was estimated. The highest value was found in the treatment 1 and variety1 that combination of T_1V_1 and the value was 4.335 and also lowest value was found in the combination of T_3V_2 which was 4.120. After 5 day the highest value was found in T_1 and V_1 combination. Similar result in the content of water and total sugar relationship was recorded by (Shi *et al.*, 2010).

Vitamin C

The research analysis showed that , vitamin C was gradually increased in the T_1 to T_2 and T_3. The amount of Vitamin C was (13.075) for T_1, T_2 was (13.113) and lowest total sugar was observed in the T_3 treatment (13.220). The Vitamin C content in sprouts increased during the sprouting process. (Xu *et al.*, 2010) also found that Vitamin C content in soybean sprout was increased after 7-10 days of sprouting. In the study highest Vitamin C was found in V_2 and lower Vitamin C content was found V_1. Furthermore , Vitamin C was higher in V_2 (13.671) and lower in V_1 (12.642). The highest value was found in the combination of T_3V_2 and the value was (13.70) and the lowest value was found in the combination of T_1V_1 which was (12.60). After 5 day the highest value was found in treatment 3 and variety 2 combination of T_3V_2. The nutritional value of the lupine sprouts increased significantly owing to the increase of the vitamin C in the course of two, three, four, five, six and nine days of sprouting (Xu *et al.*, 2005).

Conclusion

Based on the spraying time and selected physico- chemical properties it was revealed that BARI Mugebean 5 was superior than BARI Mugebean 2. Depend on the findings of the research , further investigation is necessary to observe the quality of mung bean sprout with using more spraying time.

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DECLARATIONS

Author contribution statement

Conceptualization: MFH and MNH; Methodology: MNH and STID; Software and validation: MZR and MFH; Formal analysis and investigation: MZR, MFH and STID; Data curation: STI D, SCS and MZR; Writing—original draft preparation: STID, SCS; Writing—review and editing: STID, SCS and MFH; Visualization: STID and SCS; Supervision: MFH and MNH; All authors have read and agreed to the published version of the manuscript.

Conflicts of interest: The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

Ethics approval: This study did not involve any animal or human participant and thus ethical approval was not applicable.

Consent for publication: All co-authors gave their consent to publish this paper in AAES.

Data availability: The data that support the findings of this study are available on request from the corresponding author.

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