# *Original Research Article*

# EFFECT OF ORGANIC SEED PRIMING ON GERMINATION AND SEEDLING GROWTH OF PUMPKIN (C*ucurbita pepo* L. cv. Honey Dessert) IN SINDHULI, NEPAL

# 

# ABSTRACT

Pumpkin is a high-value vegetable in Nepal, known for its unique flavor and market demand. However, low and inconsistent germination rates along with poor seedling vigor remain key challenges in its cultivation. To address these issues, seed priming is a viable option. Hence, an experiment was conducted from March to May, 2024 at Marin, Sindhuli, Nepal to analyze the effect of organic seed priming techniques on germination and seedling growth of Pumpkin. The experiment was laid out in Completely Randomized Design (CRD) with seven seed priming methods i.e., T1 (Control), T2 (Hydro-priming), T3 (Cow urine 6%), T4 (Buffalo urine 6%), T5 (Pig urine 6 %), T6 (Goat urine 6%) and T7 (Human urine 6%) each replicated three times. The results showed significantly the highest germination percentage (85.18%), dry root weight (0.82g), seedling vigor index-I (1819.15) seedling vigor index-II (357.97) in seeds primed with cow urine 6%. On the other hand, the minimum germination % (53.33%), seedling height (12.46 cm), shoot length (1.34 cm), root length (16.63 cm), fresh shoot weight (24.11 g), fresh root weight (2.28 g), dry shoot weight (2.47 g), seedling vigor index-I (957.09), seedling vigor index-II (161.49) were observed in control. In conclusion, seed priming with either cow urine 6% or pig urine 6% could be utilized as an option to enhance the germination and seedling growth of Pumpkin under greenhouse condition.

*Keywords: Organic seed priming, Pumpkin, Cow urine, Germination, Seedling growth*

# 1. INTRODUCTION

Pumpkin (2n = 2x = 40) is a seasonal vegetable crop that belongs to the family Cucurbitaceae and genus *Cucurbita* are among the largest vegetable crops. This plant family is considered one of the largest families in the plant Kingdom with a large number of edible plants with 8 tribes, 118 genera, and 825 species (Hosen et al., 2021). Pumpkins are rich in fiber, vitamins, minerals, and other beneficial compounds (Djutin, 1991). Its popular medicinal uses are as antidiabetic, antihypertension, antitumor, immunomodulation, antibacterial, anti-hypercholesterolemia, intestinal anti-parasitic and anti-inflammation. Furthermore, pumpkins also contain polysaccharides, proteins and peptides, para-amino benzoic acid, phenolic compounds, terpenoids, and sterols.

Seed priming, also known as seed conditioning or pre-sowing hydration, is a method where seeds are soaked in water or other solutions for a specific period and then re-dried before planting. Seed priming is a simple, effective, and inexpensive method to aline up germination and early seedling growth by increasing the speed of germination, seed vigor and overcoming dormancy, and allowing better establishment and high-quality yields of plants in stressful and stress-free environmental conditions (Sheferie, 2023).

Poor seed germination and uneven seedling growth has obstructed farmers from obtaining higher production and lead to financial losses. This study will be relevant to find out appropriate priming method and their effect for better seed germination and seedling growth of pumpkin in Marin. Hence the research experiment was conducted to assess the effect of organic seed priming on germination and seedling growth of Pumpkin at Marin, Sindhuli, Nepal

### Hydro-priming

Hydro-priming is a technique which uses water to soak seeds, drying it for dehydrating and then sowing the next day. This leads to increase in process of germination, accelerates seedling growth and strength (V. A. Pawar, 2018).

### Osmo-priming

Priming with osmotic solutions is a seed invigoration technique of immersing seeds in the solution of osmolytes like PEG, glycerol, mannitol, or sorbitol for a specific duration and then air drying. This method restricts the entry of excess water into the seed during imbibition, reducing ROS accumulation and protecting the cells from oxidative injury.

### Halo-priming

Halo-priming is a technique which involves submerging seeds in solutions of inorganic salts viz. sodium chloride, potassium chloride, potassium nitrate, calcium chloride etc. (V. A. Pawar, 2018).

### Hormonal priming

Hormonal seed priming is a technique that involves immersing seeds in a solution containing optimal concentrations of phytohormones, which enhances their metabolism (Amir et al., 2024). The process is known to improve germination, seedling growth, and yield by promoting nutrient uptake through increased physiological activities and root production.

### Organic priming

In organic priming, material needed for priming is obtained from natural source like: bovine urine, leaf extract, plant exudates etc. Growth-promoting hormones are present in cow dung (Shinde & Malshe, 2015). Growth regulators, nutrients, and trace elements are physiologically active chemicals that are present in cow urine (Karki et al., 2023).

Cow urine has been considered as very useful in agricultural operations as a bio fertilizer and bio pesticide. It is rich source of macro, micronutrients and has disinfectant and prophylactic properties thus purify the atmosphere and improve soil fertility (Pathak and Ram, 2013). Cow urine contains about 1.0% nitrogen, traces of P2O5 and 1.0% of K2O (Kumar, 2014).

# 2. MATERIALS AND METHODS

## 2.1 Location of the experimental site

The site was selected in Marin VDC-7 of Sindhuli district. It is located at latitude 27.2636° or 27°15′49″ north, longitude 85.7381° or 85°44′17″ east & is at an altitude of 300 masl. Top-ventilated poly-house of the college of natural resource management, kapilakot sindhuli was selected for the study.

## 2.2 Experimental design

Experiment was conducted in Completely Randomized Design (CRD) which consist of seven different priming methods so that the number of the treatment under the study was seven and for each treatment three replication were done. In each experimental unit, 45 seeds were sown and from each experimental unit ten seedlings were selected as sample plant.

## 2.3 Treatment details

Concentration of urine from different animal source were taken to 6 % because of the highest effectiveness on seed germination and seedling growth parameter (Kumar P, 2017).

**Table 1. Details of the treatment used in the experiment**

|  |  |
| --- | --- |
| **Treatments** | **Details** |
| T1 | Control |
| T2 | Priming with normal tap water for 24 hours |
| T3 | Priming with 6% cow urine for 24 hours |
| T4 | Priming with 6% buffalo urine for 24 hours |
| T5 | Priming with 6% pig urine for 24 hours |
| T6 | Priming with 6% goat urine for 24 hours |
| T7 | Priming with 6% human urine for 24 hours |

**2.4 Sterilization of tray**

Pumpkin seed of variety honey desert was selected for the seed priming and plastic tray was sterilized with the help of sodium hypochlorite in order to kill the harmful pathogen present on it.

## 2.5 Preparation of seed priming media and process of priming

For hydro-priming, seed soaked in 100ml tap water for 24 hours. For 6% cow urine priming, (mixed 6 ml cow urine solution in 94 ml of water to prepare total 100 ml solution) and the seed was soaked in the solution for 24 hours. For 6% buffalo urine priming, (mixed 6 ml buffalo urine solution in 94 ml of water to prepare total 100 ml solution) and the seed was soaked in the solution for 24 hours. For 6% pig urine priming, (mixed 6 ml solution in 94 ml of water to prepare total 100 ml solution) and the seed was soaked in the solution for 24 hours. For 6% goat urine priming, (mixed 6 ml solution in 94 ml of water to prepare total 100 ml solution) and the seed was soaked in the solution for 24 hours. For 6% human urine priming, (mixed 6 ml solution in 94 ml of water to prepare total 100 ml solution) and the seed was soaked in the solution for 24 hours. The primed seed were redried to original moisture content before sowing.

## 2.6 Preparation of growing media and sowing of seed

Mixed thoroughly Coco peat, vermicompost and FYM in 1:1:1 ratio on the basis of volume. Each cell of the tray was filled with growing media. Seed was directly sown on the cell of plastic tray. Single seed was sown on tray cell and total of 45 seed of single priming method was sown for each experimental unit.

**2.7 Irrigation**

Irrigation was done with help of hand sprayer once a day by covering the plastic tray with clean jute sacks till germination of seeds. After germination jute sacks was removed from seedlings tray.

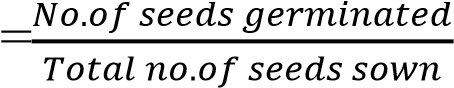
## 2.8 Data collection

Different seed germination and seedling growth parameters were observed from 10 seedlings selected randomly from each experimental unit

. The following data were collected.

**2.8.1 Germination percentage (%)**

Total number of germinated seeds out of total seeds sown was recorded for each replication of each treatment. Total count was taken in percentage. Germination percentage of seedlings with different priming method were calculated using the following formula

Germination percentage × 100%

**2.8.2 Shoot length (cm)**

Length of stem excluding root from ten sample plants was measured from each experimental at 24 DAS by using measuring scale. Shoot length was computed and expressed in centimeters.

**2.8.3 Root length (cm)**

At first all the media was removed carefully which was attached to the roots. After cleaning, length of the root was measured excluding the stem and by removing all the attached media using scale.

**2.8.4 Fresh and dry weight of shoot (g)**

The fresh shoot weight was measured excluding the root from the seedling. Then the shoots were placed in a hot air oven set at 105°C for 24 hours to ensure complete drying. It was measured in gram (g)

**2.8.5 Fresh and dry weight of root (g)**

The fresh root weight was measured excluding the shoot from the seedling. Then the roots were placed in a hot air oven set at 105°C for 24 hours to ensure complete drying. It was measured in gram (g)

**2.8.6 Seedling vigour index (SVI)**

Seed vigour is defined by ISTA as “the sum total of those properties of the seed which determine the level of activity and performance of the seed of seed lot during germination and seedling emergence. Seed which perform well are termed ‘high vigour’ seeds. The seed vigour index was calculated as:

* + 1. Seed vigour index-I= % germination × seedling length (cm)
    2. Seed vigour index-II= % germination ×seedling dry weight (g)

## 2.9 Data analysis

Data were systematically arranged on the basis of various parameters in Microsoft Excel. To determine the significance difference between treatments, analysis of variance (ANOVA) was carried out using R studio version 4.4.1 and DMRT was used for mean separation at 5% level of significance.

# 3. RESULTS

The experiment was conducted to study the effect of seed priming on germination and seedling growth of Pumpkin (*Cucurbita pepo* L.). Germination and growth parameters were measured and the significant difference between the treatments were analyzed. The results of each parameter have been presented in the form of tables below.

## 3.1 Germination percentage (%), Seedling Vigor Index-I and Seedling Vigor Index-II

The result on germination percentage, Seedling Vigor Index-I and Seedling Vigor Index-II as influenced by different seed priming methods have been presented in Table 2. The result showed that the germination percentage was very highly significant in cow urine (85.18%). Goat urine (72.59%) was statistically par with buffalo urine (69.62%) while the lowest germination percentage (53.33%) was observed in control.

Seedling vigor index-Iwas very highly significant in cow urine 6% (1819.15) which was statistically at par with goat urine (1694.46), buffalo urine (1518.37), pig urine (1518.17), hydro-priming (1404.03) while the lowest seedling vigor index-II (957.09) was observed in control.

Seedling vigor Index-IIwas very highly significant in cow urine 6% (357.97). Pig urine (250.77) which was statistically at par with goat urine (232.23), human urine (231.55) while the lowest seedling vigor index-II (161.59) was observed in control.

**Table 2. Effect of seed priming on germination percentage, Seedling Vigor Index-I and II of Pumpkin (*Cucurbita pepo* L. cv. Honey Dessert) at Marin, Sindhuli, Nepal, 2024**

|  |  |  |  |
| --- | --- | --- | --- |
| **Treatments** | **Germination %** | **Seedling Vigor Index-I** | **Seedling Vigor Index- II** |
| Control (No soaking) | 53.33d | 957.09e | 161.59d |
| Water soaking | 61.48c | 1404.03cd | 193.23cd |
| Cow urine 6% | 85.18a | 1819.15a | 357.97a |
| Buffalo urine 6% | 69.62b | 1518.37bc | 263.02b |
| Pig urine 6% | 58.51cd | 1518.17bc | 250.77bc |
| Goat urine 6% | 72.59b | 1694.46ab | 232.23bc |
| Human urine 6% | 58.51cd | 1263.06d | 231.55bc |
| **CV (%)** | 5.121 | 9.58 | 14.07 |
| **LSD (0.05)** | 6.81 | 243.90 | 59.50 |
| **Grand Mean** | 65.60 | 1453.4 | 1154.7 |
| **SEm (±)** | 1.93 | 80.41 | 19.61 |
| **F-test** | \*\*\* | \*\*\* | \*\*\* |

(Note: Means within the column followed by the same letter/s are non-significant at 5% level of significance by DMRT. \* Significant at 5% (P<0.05), \*\* significant at 1% (P<0.01), \*\*\* significant at 0.1% (P<0.001), NS= non-significant, SEm= Standard Error of mean, LSD= Least significant difference, CV= Coefficient of variance)

## 3.2 Seedling height (cm), Shoot length (cm) and Root length (cm)

The results on seedling height, shoot length and root length as influenced by different seed priming methods have been presented in Table 3. The result showed that the seedling height was very highly significant in pig urine (16.88). Goat urine 6% (15.93cm). which was statistically at par with cow urine 6% (15.15cm) and buffalo urine (15.11 cm). The lowest seedling height was observed from control (12.43cm).

Shoot length was significantly the highest in pig urine 6% (2.60 cm). Goat urine (2.19 cm) which was statistically at par with buffalo urine (2.09 cm), hydro-priming (1.96). The lowest shoot length was observed in control (1.34 cm).

Root length was significant with seed priming with pig urine 6% (23.35 cm) which was statistically at par with goat urine 6% (21.29 cm), hydro priming (20.89 cm), human urine (19.86), buffalo (19.73 cm), cow urine (19.58 cm). The lowest shoot length was observed in control (16.63 cm).

**Table 3. Effect of seed priming on seedling height, Shoot length and Root length of Pumpkin (Cucurbita pepo L. cv. Honey Dessert) at Marin, Sindhuli, Nepal, 2024**

|  |  |  |  |
| --- | --- | --- | --- |
| **Treatments** | **Seedling height (cm)** | **Shoot length(cm)** | **Root length(cm)** |
| Control (No priming) | 12.43e | 1.34c | 16.63c |
| Hydro-priming | 14.18cd | 1.96b | 20.89ab |
| Cow urine 6% | 15.15bc | 1.72bc | 20.89ab |
| Buffalo urine 6% | 15.11bc | 2.09b | 19.73bc |
| Pig urine 6% | 16.88a | 2.60a | 23.35a |
| Goat urine 6% | 15.93ab | 2.10b | 21.29ab |
| Human urine 6% | 13.49de | 1.69bc | 19.86bc |
| **CV (%)** | 5.22 | 13.70 | 8.93 |
| **LSD (0.05)** | 1.37 | 1.03 | 1.15 |
| **Grand Mean** | 14.74 | 1.93 | 20.19 |
| **SEM (±)** | 0.44 | 0.15 | 1.04 |
| **F-test** | \*\*\* | \* | \* |

(Note: Means within the column followed by the same letter/s are non-significant at 5% level of significance by DMRT. \* Significant at 5% (P<0.05), \*\* significant at 1% (P<0.01), \*\*\* significant at 0.1% (P<0.001), NS= non-significant, SEm= Standard Error of mean, LSD= Least significant difference, CV= Coefficient of variance)

## 3.3 Fresh Shoot weight (g) and Fresh Root weight (g)

The result on fresh shoot weight and fresh root weight as influenced by different seed priming methods have been presented in Table 4. The result showed that the shoot weight was very highly significantly in pig urine 6% (36.88g) which was statistically at par with cow 6% (35.12g) as well as goat urine (33.81), human urine 6% (32.64g), hydro-priming (30.50g) while the lowest shoot weight was observed in Control (24.11g) followed by buffalo urine.

Root weight was very highly significant weight in pig urine (4.39g) which was statistically at par with cow urine 6% (3.91g), as well as human urine (3.62g), hydro-priming (3.42), while the lowest root weight (2.28 g) was observed in control.

T**able 4. Effect of seed priming on fresh shoot weight and fresh root weight of Pumpkin (Cucurbita pepo L. cv. Honey Dessert) at Marin, Sindhuli, Nepal, 2024**

|  |  |  |
| --- | --- | --- |
| **Treatments** | **Fresh shoot weight (g)** | **Fresh root weight (g)** |
| Control (No priming) | 24.11c | 2.28d |
| Hydro-priming | 30.50b | 3.42c |
| Cow urine 6% | 35.12a | 3.91b |
| Buffalo urine 6% | 25.80c | 3.38c |
| Pig urine 6% | 36.88a | 4.39a |
| Goat urine 6% | 33.81ab | 3.16c |
| Human urine 6% | 32.64ab | 3.62bc |
| **CV (%)** | 7.45 | 7.53 |
| **LSD (0.05)** | 0.161 | 0.045 |
| **Grand Mean** | 31.23 | 3.54 |
| **SEM (±)** | 1.341 | 0.15 |
| **F-test** | \*\*\* | \*\*\* |

(Note: Means within the column followed by the same letter/s are non-significant at 5% level of significance by DMRT. \* Significant at 5% (P<0.05), \*\* significant at 1% (P<0.01), \*\*\* significant at 0.1% (P<0.001), NS= non-significant, SEm= Standard Error of mean, LSD= Least significant difference, CV= Coefficient of variance)

## 3.4 Dry shoot weight (g) and Dry root weight (g)

The result on dry shoot weight and dry root weight as influenced by different seed priming methods have been presented in Table 5. The result showed that the dry shoot weight was significant in pig urine 6% (3.60g) which was statistically at par with cow urine (3.36g), buffalo urine (3.08g), human urine (3.25g) goat urine (2.63g) while the lowest dry root weight was observed in control (2.47 g).

Dry root weight was significant in cow 6% (0.82) which was statistically at par with buffalo urine (0.70g), human urine (0.68g), pig urine (0.67g), hydro-priming (0.62g) while the lowest dry root weight was observed in control (0.55 g).

**Table 5. Effect of seed priming on dry shoot weight and dry root weight of Pumpkin (Cucurbita pepo L. cv. Honey Dessert) at Marin, Sindhuli, Nepal, 2024**

|  |  |  |
| --- | --- | --- |
| **Treatments** | **Dry shoot weight(g)** | **Dry root weight (g)** |
| Control (No priming) | 2.47d | 0.55b |
| Hydro-priming | 2.51d | 0.62b |
| Cow urine 6% | 3.36b | 0.82a |
| Buffalo urine 6% | 3.08c | 0.70ab |
| Pig urine 6% | 3.60a | 0.67ab |
| Goat urine 6% | 2.63d | 0.56b |
| Human urine 6% | 3.25bc | 0.68ab |
| **CV (%)** | 4.09 | 13.34 |
| **LSD (0.05)** | 0.013 | 0.004 |
| **Grand Mean** | 2.99 | 0.66 |
| **SEM (±)** | 0.06 | 0.05 |
| **F-test** | \* | \* |

(Note: Means within the column followed by the same letter/s are non-significant at 5% level of significance by DMRT. \* Significant at 5% (P<0.05), \*\* significant at 1% (P<0.01), \*\*\* significant at 0.1% (P<0.001), NS= non-significant, SEm= Standard Error of mean, LSD= Least significant difference, CV= Coefficient of variance)

**4. DISCUSSION**

Seed treated with cow urine (6%) has maximum germination percentage, seedling vigour index. Similar result was reported by (Kumar P, 2017). Shankaranarayanan et al. (1994) also reported that soaking of tamarind seeds in 10 per cent cow urine or cow dung solution for 24 h increased the germination and vigor index as compared to that of untreated seeds. Faster germination in primed seed than non-primed seed is likely due to its stimulation of metabolic processes during imbibition, which prepare seed for root emergence. This in turn may have weakened the endosperm, thereby promoting germination rate (Black & Bewley, 2000).

Seedling height, shoot length and root length were found to be highest in pig urine which was statistically at par with cow urine. Similar finding were reported by (Kumar P, 2017) in cotton. According to Singh et al. (2017), cow urine solution treatment can be attributed to the occurrence of growth substances like auxins and essential nutrients which ultimately led to increased seedling length and shoot length. The reason for increased length of seedling may be because of cow urine contains iron, urea, uric acid, estrogen, and progesterone which affect the inhibitory response to seed germination, shoot growth and seedling vigor (LODHI, K. D. 2019).

The vigorous growth of roots can also be associated with the presence of auxins and nutrients in cow urine. This phenomenon has been supported by studies conducted by (Shinde & Malshe, 2015). Accordingly, this enzyme's activation leads to increased extensibility of the embryonic cell wall and the early emergence of radicals.

Similarly, Rajput et al. (2020), also found that priming the custard apple seeds with 100% cow urine before sowing led to greater fresh and dry root weights of the seedlings. Comparable results have also been reported by Ambika and Balakrishnan (2015) on cluster bean seeds. These collective studies emphasize the concept that the utilization of cow urine for seed priming can produce enhanced root growth and subsequent dry matter production.

# 5. CONCLUSION

The present experiment suggest that significant variations were observed among different seed priming methods on various seed germination and seedling growth parameters of Pumpkin. Priming pumpkin (*Cucurbita pepo* L. cv. Honey Dessert) seeds with Cow urine 6% proved to be most effective for earliest germination and highest germination percentage. Seedling height, shoot length, root length, fresh shoot weight, fresh root weight, dry shoot weight was significantly improved by pig urine 6% while dry root weight, seed vigor index I, seed vigor index II maximum result was shown by Cow urine. Control treatment consistently produced the lowest results in most of the germination and seedling growth parameters. Hence, either cow urine (6%) or pig urine (6%) can be utilized as an option for better seed germination and seedling growth to increase the yield of pumpkin.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declares that NO generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts.

# REFERENCES

Ambika, S. and Balakrishnan, K. (2016). Organic priming in pumpkin - An eco-friendly approach for sustainable agriculture. Internat. J. agric. Sci., 12 (2): 261-264, [DOI:10.15740/HAS/IJAS/12.2/261-264.](https://www.cabidigitallibrary.org/doi/full/10.5555/20163360122)

Amir, M., Raheem, A., Yadav, P., Kumar, V., Tewari, R. K., Jalil, S. U., ... & Ansari, M. I. (2024). Phytofabricated gold nanoparticles as modulators of salt stress responses in spinach: implications for redox homeostasis, biochemical and physiological adaptation. *Frontiers in Plant Science*, *15*, 1408642**.**

Balakrishnan, P., Kannan, P., Mahendran, P. P., Sherene, T., & Arunachalam, P, 2015. Evaluation of Crops and varieties for Salt Tolerance.

Djutin K. E. (1991). Pumpkin: nutritional properties. In: Potatoes and vegetables. 3 pp 25-26.

Hosen, M., Rafii, M. Y., Mazlan, N., Jusoh, M., Oladosu, Y., Chowdhury, M. F. N., Muhammad, I., & Khan, M. M. H. (2021). Pumpkin (*Cucurbita* spp.): A Crop to Mitigate Food and Nutritional Challenges. Horticulturae, 7(10), 352. <https://doi.org/10.3390/horticulturae7100352>

Karki, N., Bhattarai, R., Ghimire, E., & Khanal, K. (2023). Effect of Various Organic Priming Treatments on the Performance of Bittergourd (Momordica Charantia L). *Nepal Journal of Science and Technology*, *22*(1), 76–84. <https://doi.org/10.3126/njst.v22i1.67164>

Kumar, M. (2014). Influence of seed priming with urine, phosphorus and zinc on maize (Zea mays L.) yield in an acid soil of Northeast India. *Indian J. Hill Farming*, *27*(1), 132-137.

LODHI, K. D. (2019). *Effect of different concentrations and soaking time in cow urine, cow dung, hot and cold water as a seed treatment on germination and growth of bael (Aegle marmelos L.)* (Doctoral dissertation, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya).

Pathak, R.K. and Ram, R.A. (2013) Bio-Enhancers: A Potential Tool to Improve Soil Fertility, Plant Health in Organic Production of Horticultural Crops. Progressive Horticulture, 45, 237-254.

Pawar, V. A., & Laware, S. L. (2018). Seed priming a critical review. *Int. J. Sci. Res. Biol. Sci*, *5*(5), 94-101.

Rajput, K. E. E. R. T. I., & Sharma, T. R. (2020). Effect of organic and inorganic sources on seed germination, growth and survival of custard apple (Annona squamosa L.) seedlings. *Journal of Pharmacognosy and Phytochemistry*, *9*(6), 552-556.

Sankaranarayana, R. M., Kumar, V., & Rangasamy, P. (1994). Cow urine ideal seed germination in Tamarinds Indian Hort. *J*, *38*(4), 15.

Singh, V., Gera, R., Purohit, M. P., Patnaik, S., & Ghosh, D. (2017). Fluorometric estimation of glutathione in cultured microglial cell lysate. *Bio-protocol*, *7*(11), e2304-e2304.

Thanuja, S., Sivakanthan, S., & Vasantharuba, S. (2019). Effect of different cooking methods on the antioxidant properties of bitter gourd (Mormodica charantia) cultivated in Jaffna district. *Journal of Agricultural Sciences - Sri Lanka*, *14*(2), 111–119. <https://doi.org/10.4038/jas.v14i2.8513>

Vikas et. al., (2017). Fluorometric Estimation of Glutathione in Cultured Microglial Cell Lysate, Bio-protocol 7 (11): e2304. [DOI: 10.21769/BioProtoc.2304.](https://en-cdn.bio-protocol.org/pdf/bio-protocol2304.pdf?rel_link=YmlvLXByb3RvY29sLm9yZy9lbi9icGRldGFpbD9pZD0yMzA0JnR5cGU9MA==)