Antioxidant Capacity with Physical Property Variations of *Morinda citrifolia* L. Juice in Traditional Fermentation

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Outline of Presentation

- Background
- Research problem
- Objectives
- Methodology
- Results
- Conclusions
- References

Noni (*Morinda citrifolia* L.) Fruit

Unripe fruit – hard & bright green

Ripe fruit – translucent & white/yellowish

Noni juice

One of underutilized fruits

Introduction

- Amazing **therapeutic & nutritional value.**
- Contains **phytochemicals** to prevent/cure diseases.
- Studying variation of physical parameters during traditional fermentation of noni juice **(pH & temperature of juice, temperature & humidity of fermenter & juice level).**
- Identifying correlations between these physical properties with antioxidant capacity of noni juice.

Research Problem

- Popular method for noni juice production - **traditional fermentation** (Usually **2 months**).
- How **physical parameters** vary with this time in fermentation of noni juice?

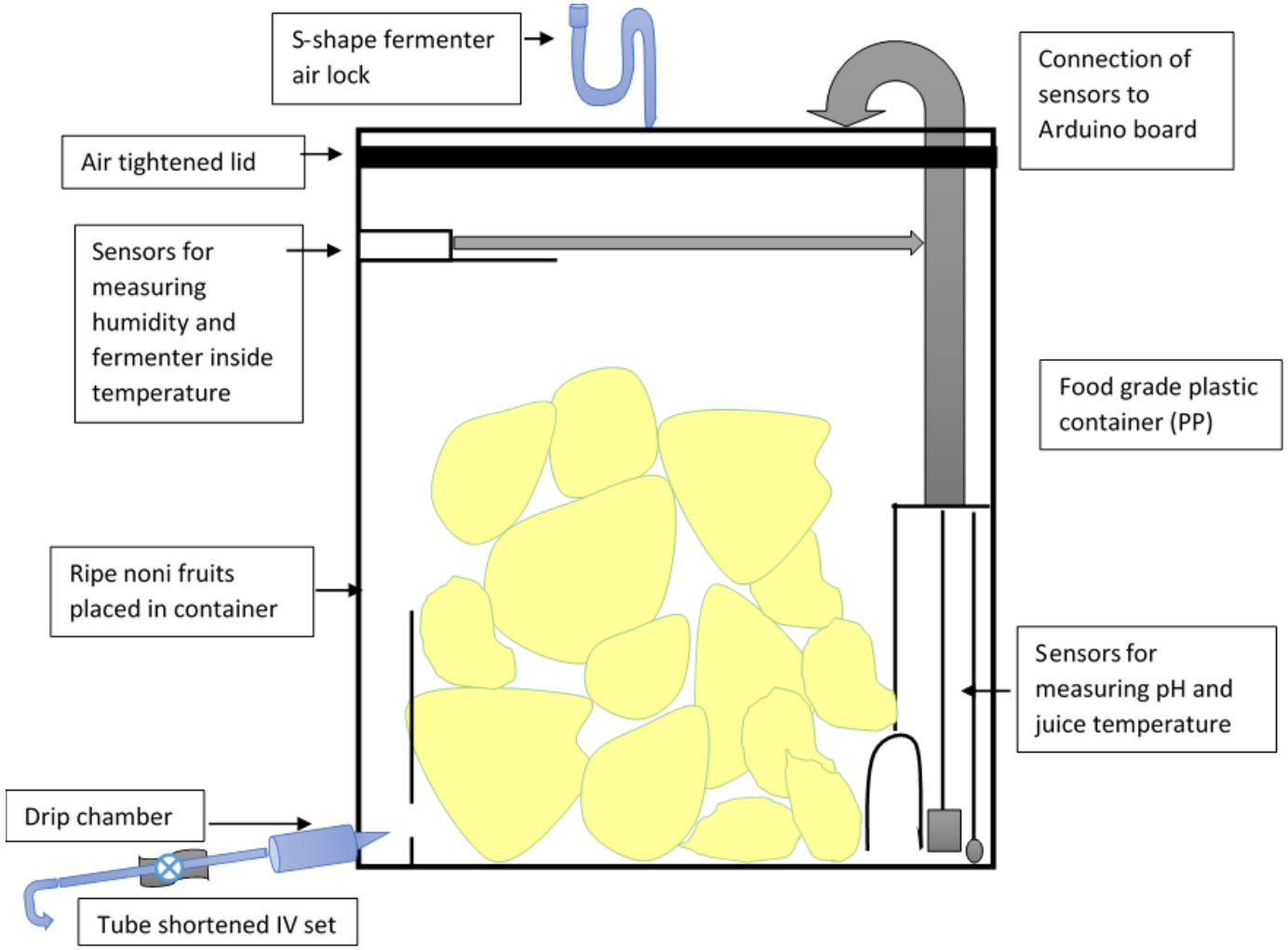
Fermenter temperature
Juice temperature
pH of noni juice
Humidity of fermenter
Level of juice formed

- **Antioxidant capacity** of noni juice varies with the fermentation conditions. How is it **correlated** with the above physical properties?

Objectives

- Determine whether there are significant variations of physical parameters with fermentation time.
- Determine whether there are any significant correlations between physical parameters and antioxidant capacity of noni juice.

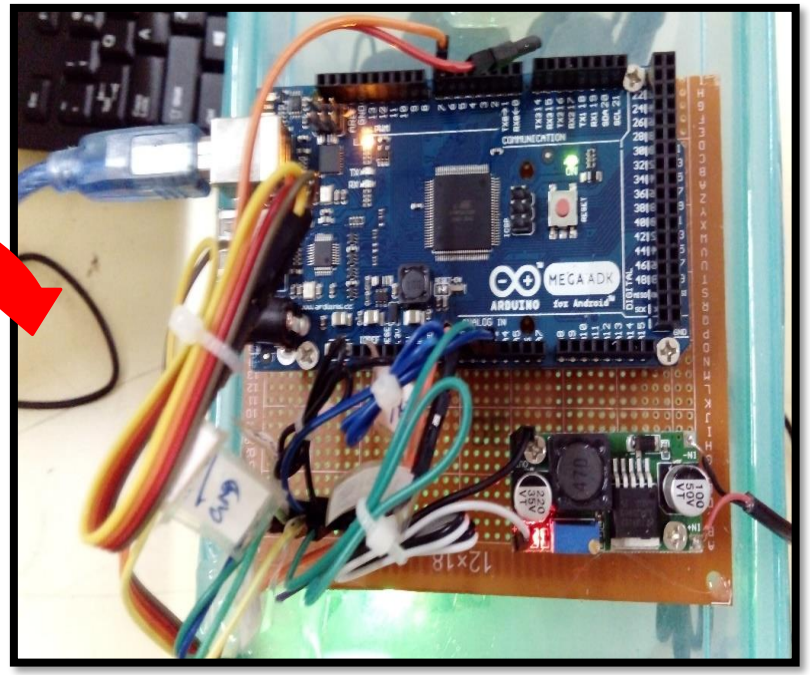
Methodology



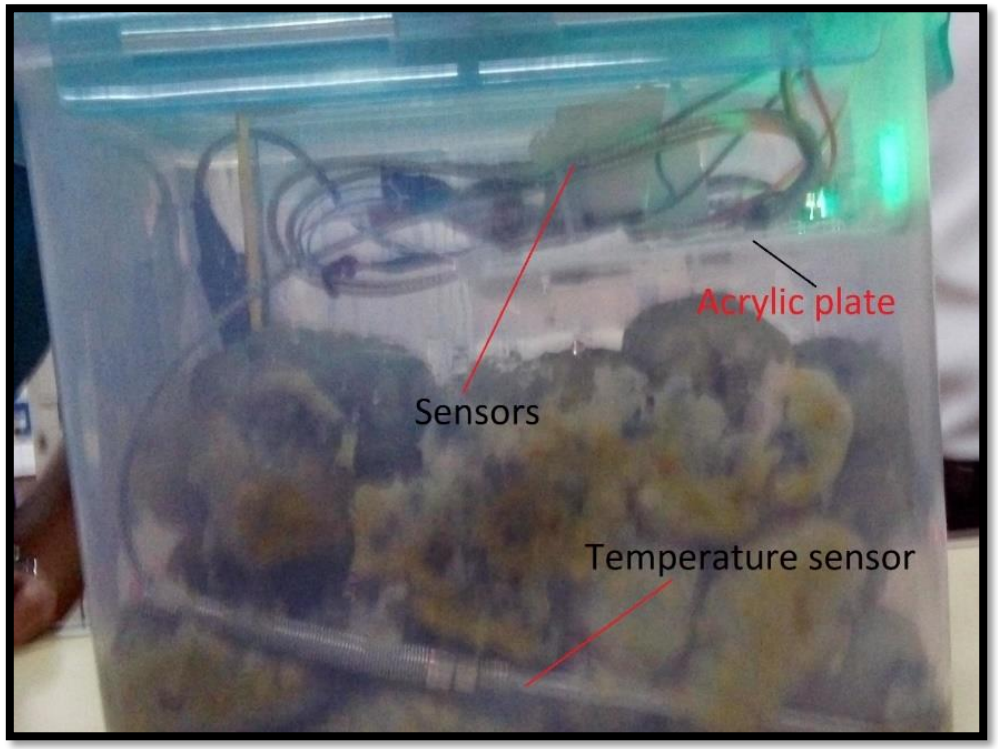
Schematic Diagram of the Fermenter

Fermenter Setup

After installing & starting execution of the coded program.

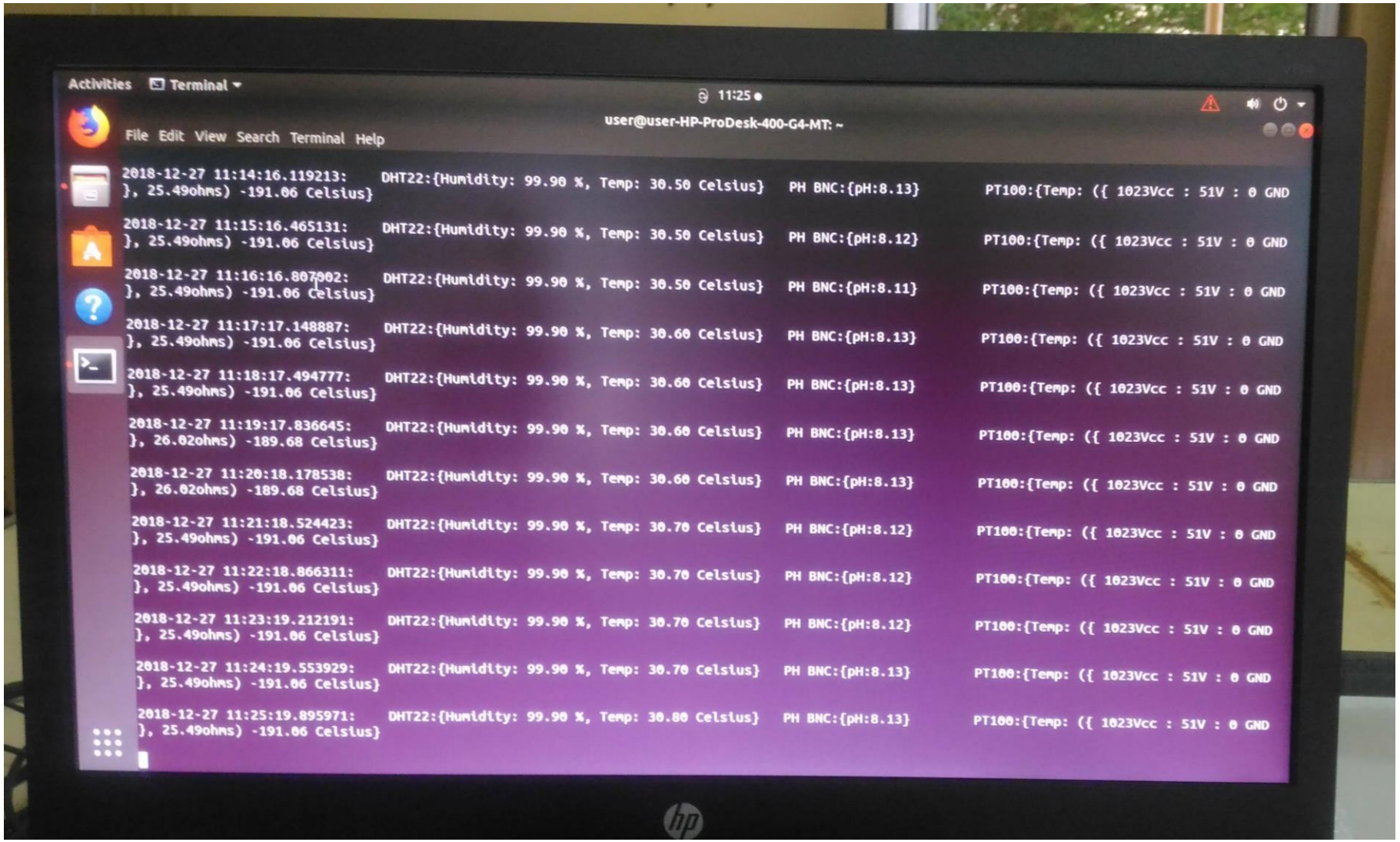


Arduino MEGA 2560 microcontroller board connected with sensors & attached to the top surface of the fermenter.



❖Determining variations of physical properties during traditional fermentation of noni juice is important.

Top View of the Fermenter



After installing & starting execution of the coded program.

Sensors Used to Measure the Physical Properties

- Temperature of the fermenting juice :

PT100 RTD with Thermometer Sensor

- pH of the fermenting juice :

Liquid PH Detect Sensor Module + PH Electrode Probe BN Arduino

- Temperature & humidity in the fermenter:

DHT22/AM2302 Digital Temperature and Humidity Sensor

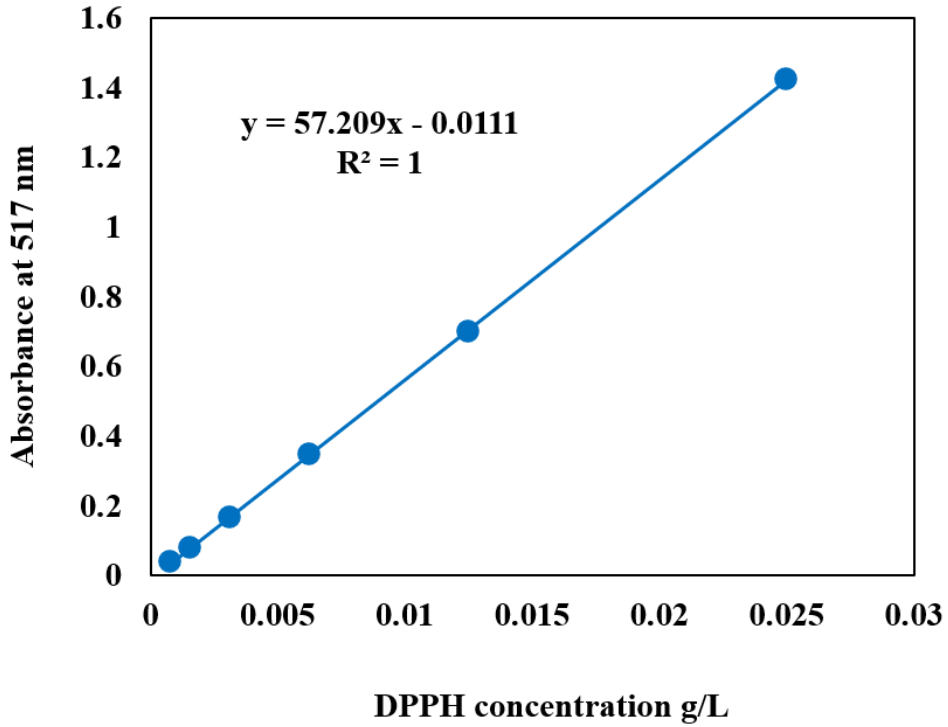
- Level of formed noni juice : **Reading manually**

Variation of Antioxidant Capacity of Noni Juice

❖Measuring antioxidant capacity (AC) of noni juice every week for 2 months.

❖Determining AC by scavenging of DPPH free radicals as explained by Brand-Williams.

❖ Determination of remaining DPPH concentrations in noni juice by using an experimentally derived standard curve of DPPH concentration vs absorbance



Correlation of Physical Properties and Antioxidant Capacity of Noni Juice

- Average data of these physical properties of noni juice were then analysed for their correlations with antioxidant capacity of noni juice.
- Correlation was determined by calculating Distance Correlation Coefficients for the obtained data.
- Distance Correlation or Distance Covariance is a measure of dependence between two paired random vectors of arbitrary, not necessarily equal, dimension.

Mathematical Equations Used for Correlation Calculation

1 $$a_{j,k} = \|X_j - X_k\| \quad j,k = 1,2,3,\ldots..,n$$

2 $$b_{j,k} = \|Y_j - Y_k\| \quad j,k = 1,2,3,\ldots..,n$$

3 $$A_{j,k} = a_{j,k} - a_j - a_k + \bar{a}$$

4 $$B_{j,k} = b_{j,k} - b_j - b_k + \bar{b}$$

5 $$v_n^2(X,Y) = \frac{1}{n^2}\sum_{j,k=1}^{n} A_{j,k} \times B_{j,k}$$

6 $$v_n^2(X) = \frac{1}{n^2}\sum_{j,k=1}^{n} A_{j,k}^2$$

7 $$v_n^2(Y) = \frac{1}{n^2}\sum_{j,k=1}^{n} B_{j,k}^2$$

8 $$R_n^2(X,Y) = \frac{v_n^2(X,Y)}{\sqrt{v_n^2(X) \times v_n^2(Y)}}$$

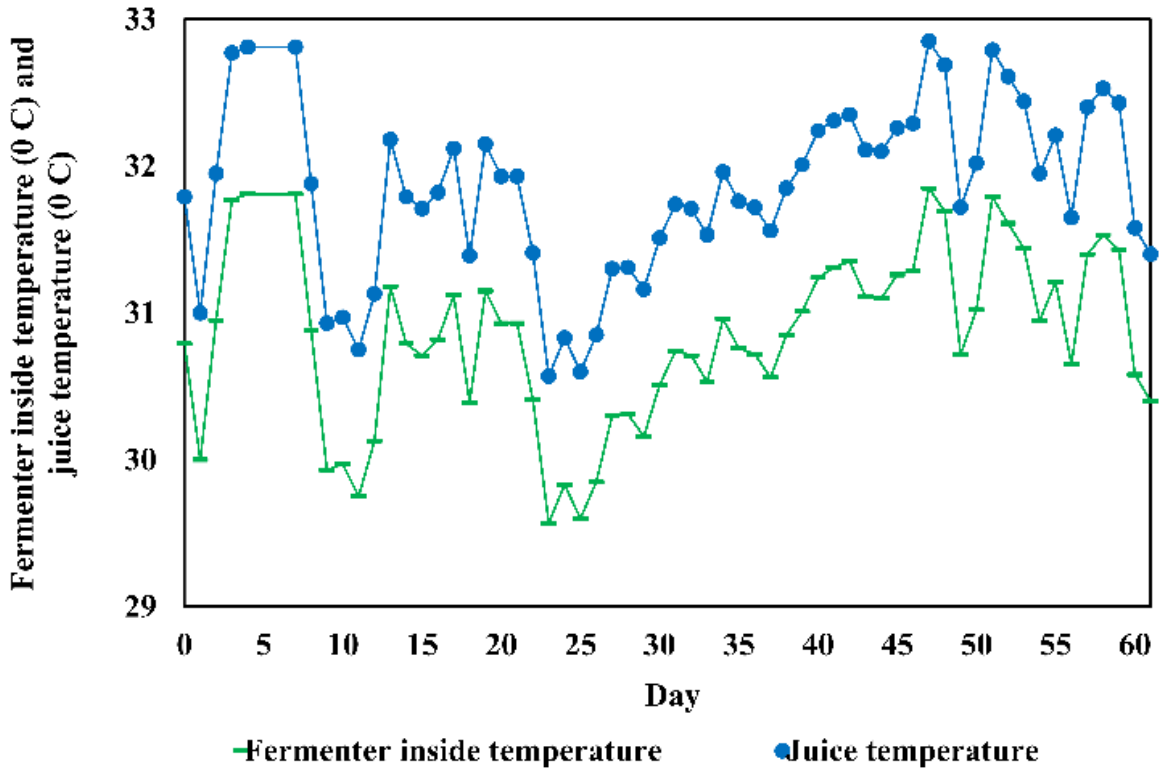
Calculation of Distance Correlation Coefficients

Distance correlations of each physical property with antioxidant capacity were calculated as follows.

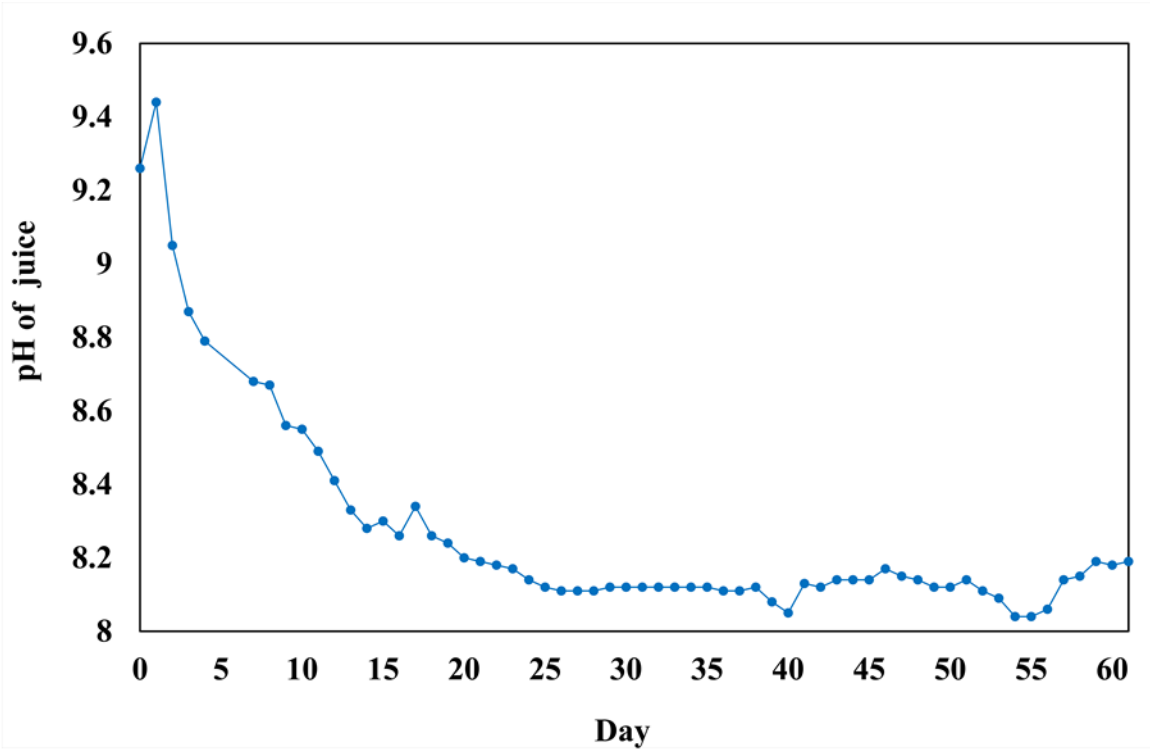
- Calculating n by n distance matrices ($a_{j,k}$) and ($b_{j,k}$) containing all pairwise distances by 1 & 2.
  - $a_{j,k}$ matrices - for each physical property & $b_{j,k}$ matrix - for antioxidant capacity
- Computing all doubly centered distances by 3 & 4 for computed distance matrices.
- Calculating squared sample distance covariance by 5.
- Calculating corresponding squared sample variances by 6 & 7.
- Computing distance correlation ($R_n(X,Y)$) of two random vectors by dividing their distance covariance by the product of their distance standard deviations by 8.

Results

Variations of physical properties during traditional fermentation of noni juice

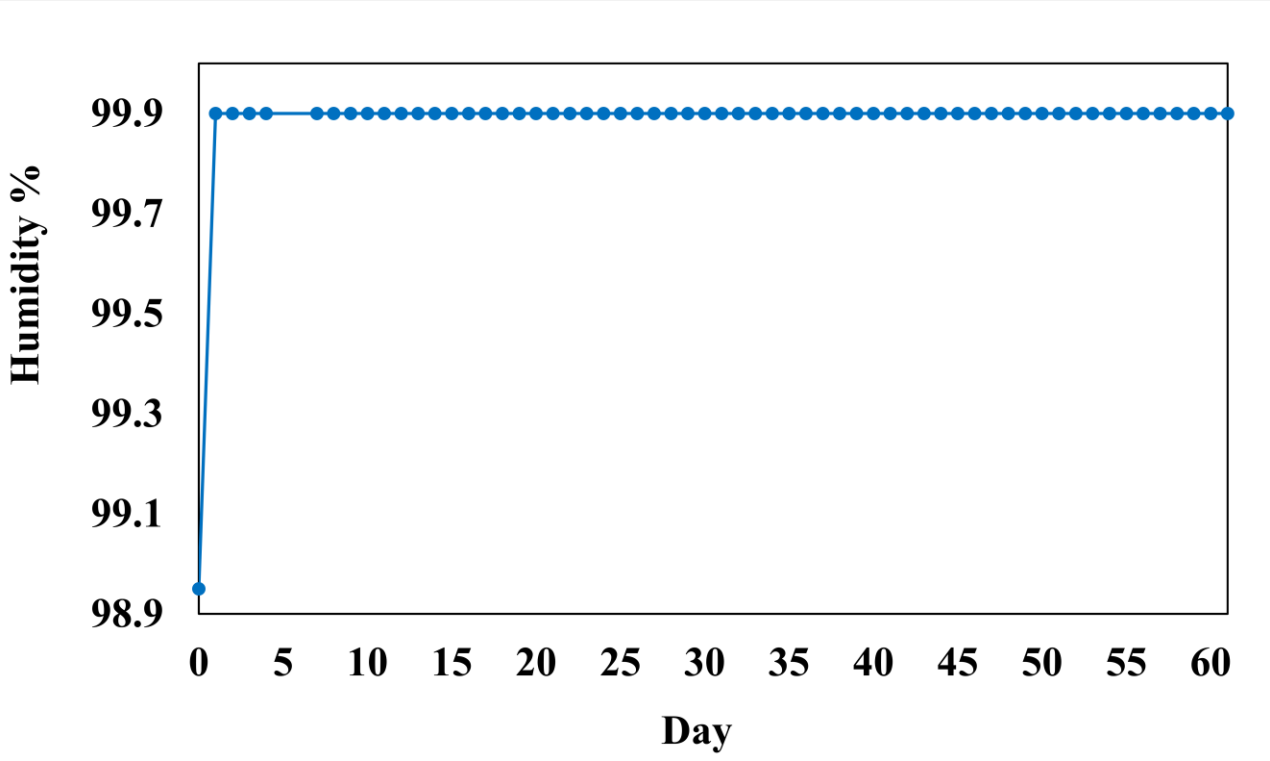


Variations of juice temperature & fermenter inside temperature

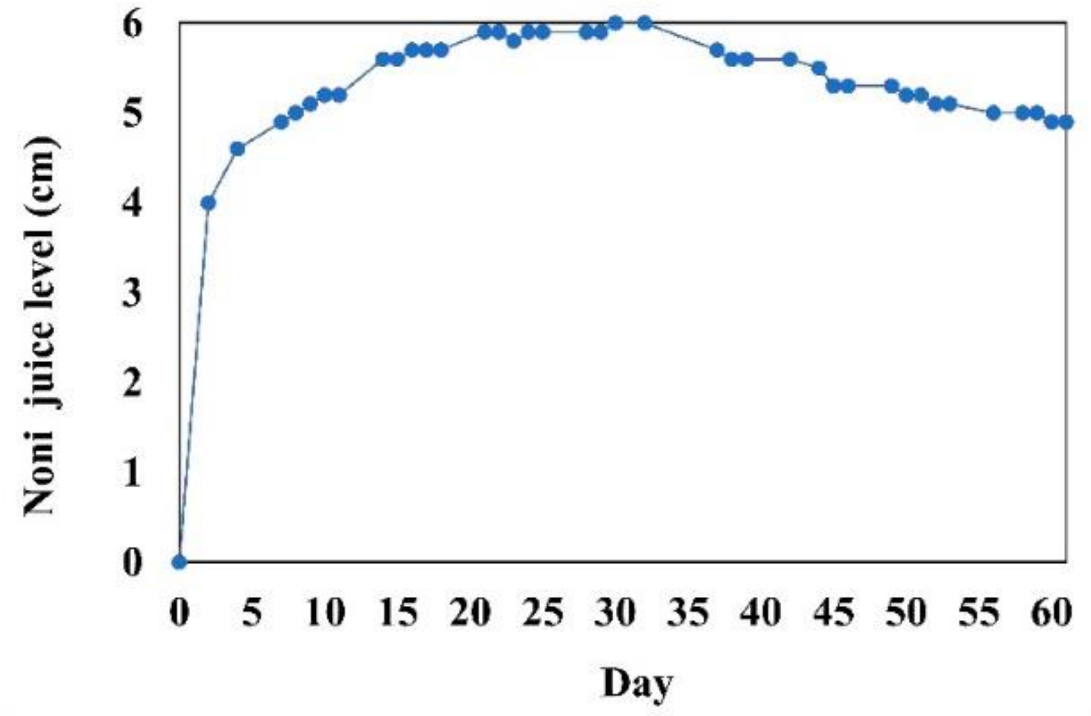


Variation of pH of noni juice

Variations of physical properties during traditional fermentation of noni juice

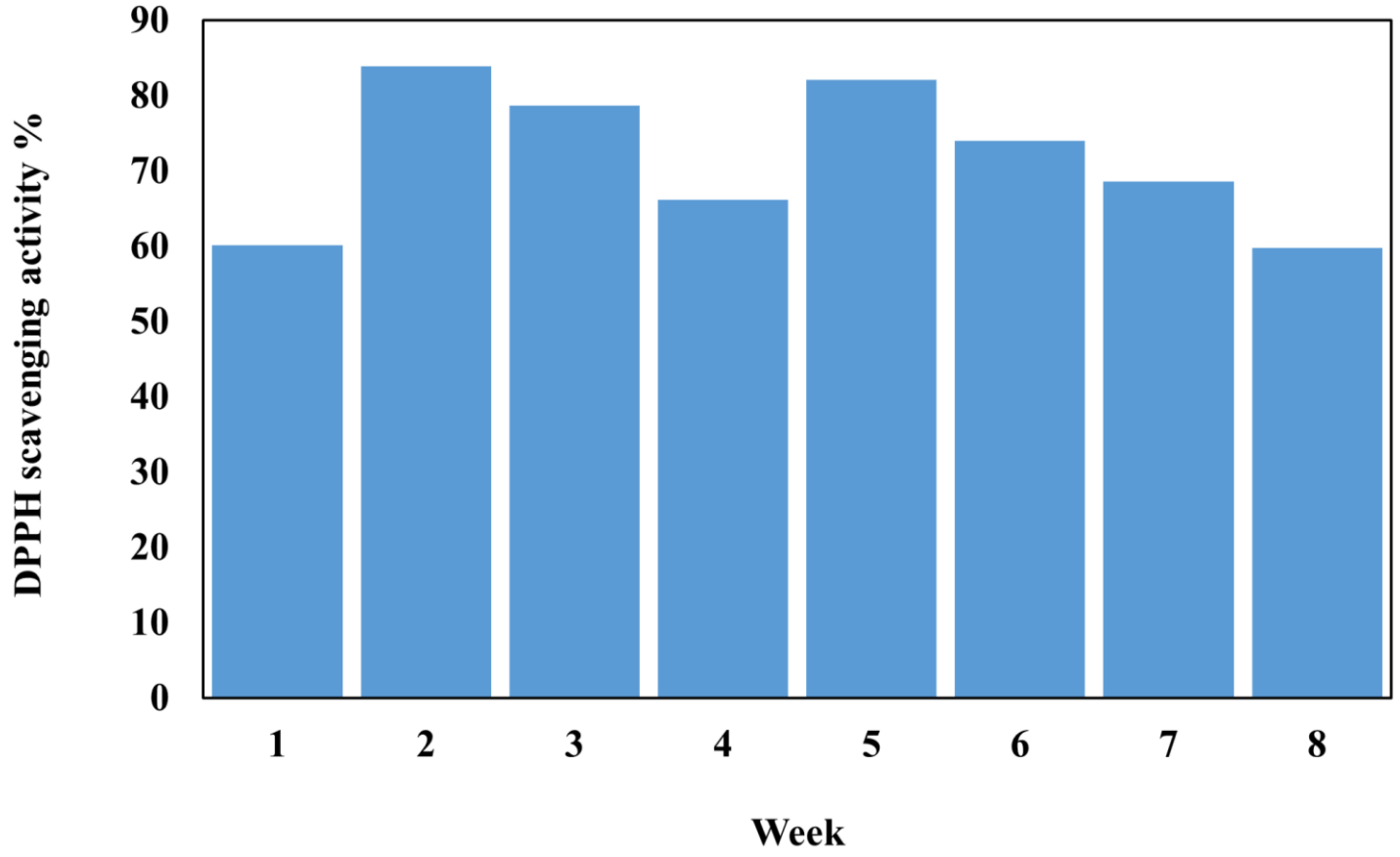


Variations of humidity within fermenter

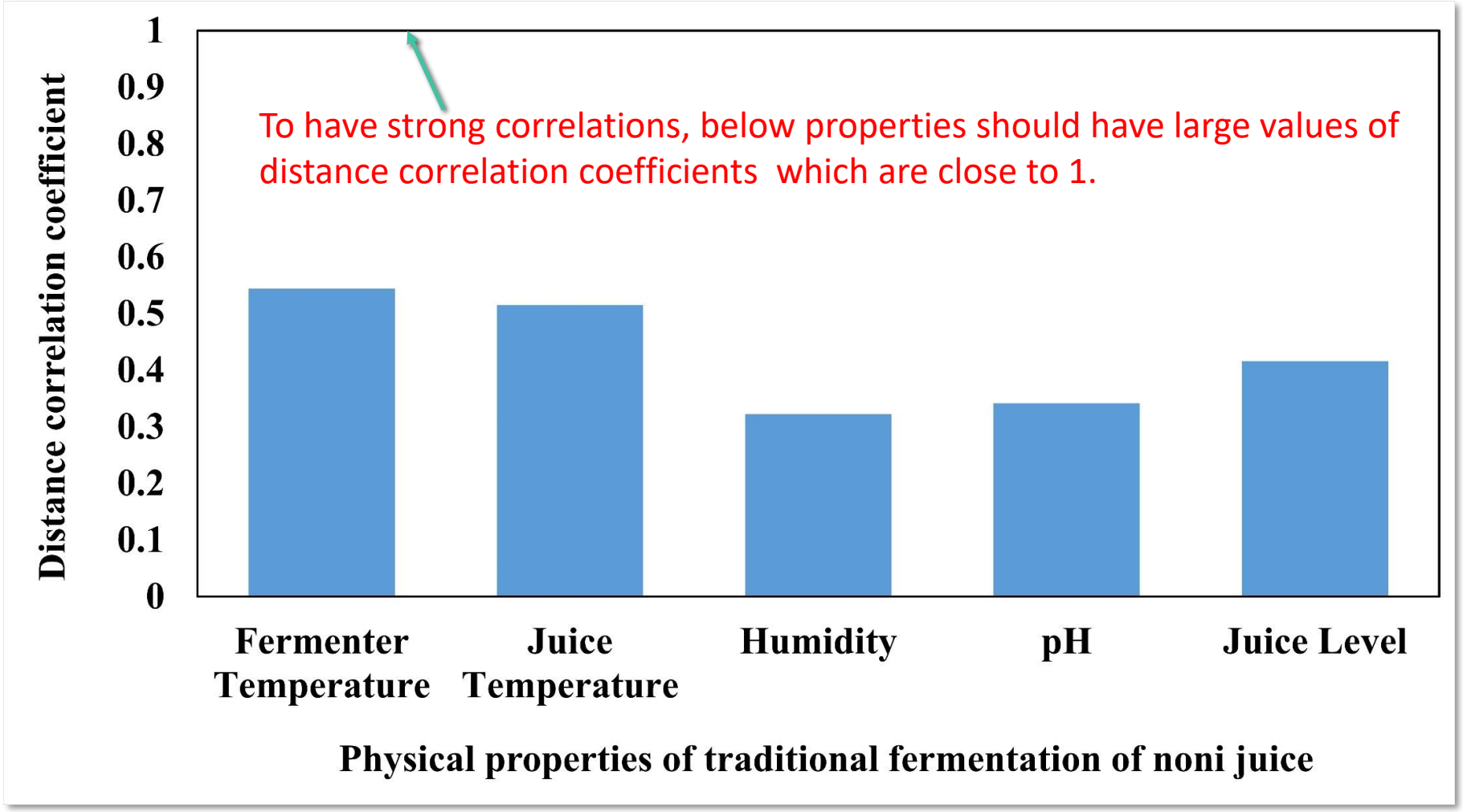


Variations of noni juice level

Variation of antioxidant capacity of noni juice during traditional fermentation



Distance correlation coefficients of physical properties of traditional fermentation of noni juice with its antioxidant capacity.



Conclusions

- Strong correlations did not exist in each physical parameter with the antioxidant capacity of noni juice.
- Patterns of variations of physical properties during traditional fermentation of noni juice were different from the variation of antioxidant capacity which was maximum at 2nd week of traditional fermentation.

References

1. Meilawati, L.; Ernawati, T.; Dewi, R.; Megawati, M. and Sukirno, S. Study of Total Phenolic, Total Flavonoid, Scopoletin Contents and Antioxidant Activity of Extract of Ripened Noni Juice. Jurnal Kimia Terapan Indonesia 2021, 23, 55-62.
2. Krishnaiah, D.; Bono, A.; Sarbatly, R.; Anisuzzaman, S. Antioxidant activity and total phenolic content of an isolated Morinda citrifolia L. methanolic extract from Poly-ethersulphone (PES) membrane separator. J. King Saud Univ. Eng. Sci. 2015, 27, 63-67.
3. Yang, J.; Paulino, R.; Janke-Stedronsky, S.; Abawi, F. Free-radical-scavenging activity and total phenols of noni (Morinda citrifolia L.) juice and powder in processing and storage. Food Chem. 2007, 102, 302-308.
4. Yang, J.; Gadi, R.; Paulino, R.; Thomson, T. Total phenolics, ascorbic acid, and antioxidant capacity of noni (Morinda citrifolia L.) juice and powder as affected by illumination during storage. Food Chem. 2010, 122, 627-632.
5. Sirilun, S.; Sivamaruthi, B. S.; Kesika, P.; Makhamrueang, N.; Chaiyasut, K.; Peerajan, S.; and Chaiyasut, C. Development and evaluation of Mustard green pickled liquid as starter for Morinda citrifolia Linn. Fermentation. Int. Food Res. J. 2017, 24, 2170–2176.
6. Sina, H.; Dramane, G.; Tchekounou, P.; Assogba, M.; Chabi-Sika, K.; Boya, B.; Socohou, A.; Adjanohoun, A. and Baba-Moussa, L. Phytochemical composition and in vitro biological activities of Morinda citrifolia fruit juice. Saudi J. Biol. Sci. 2021, 28, 1331-1335.
7. Brand-Williams, W.; Cuvelier, M.; Berset, C. Use of a free radical method to evaluate antioxidant activity. LWT - Food Sci Technol 1995, 28, 25-30.
8. Samarasiri, M.; Chandrasiri, T.; Wijesinghe, D.; Gunawardena, S. Antioxidant Capacity and Total Phenolic Content Variations
9. Székely, G.; Rizzo, M.; Bakirov, N. Measuring and testing dependence by correlation of distances. Ann. Stat. 2007, 35.
10. Konsue, N.; Yimthiang, S.; & Kwanhian, W. Effect of fermentation conditions of noni (Morinda citrifolia L.) juice on glutathione content and lipid oxidation in vero cells. Int. Food Res. J. 2018, 25, 1534–1540.

Thank You !