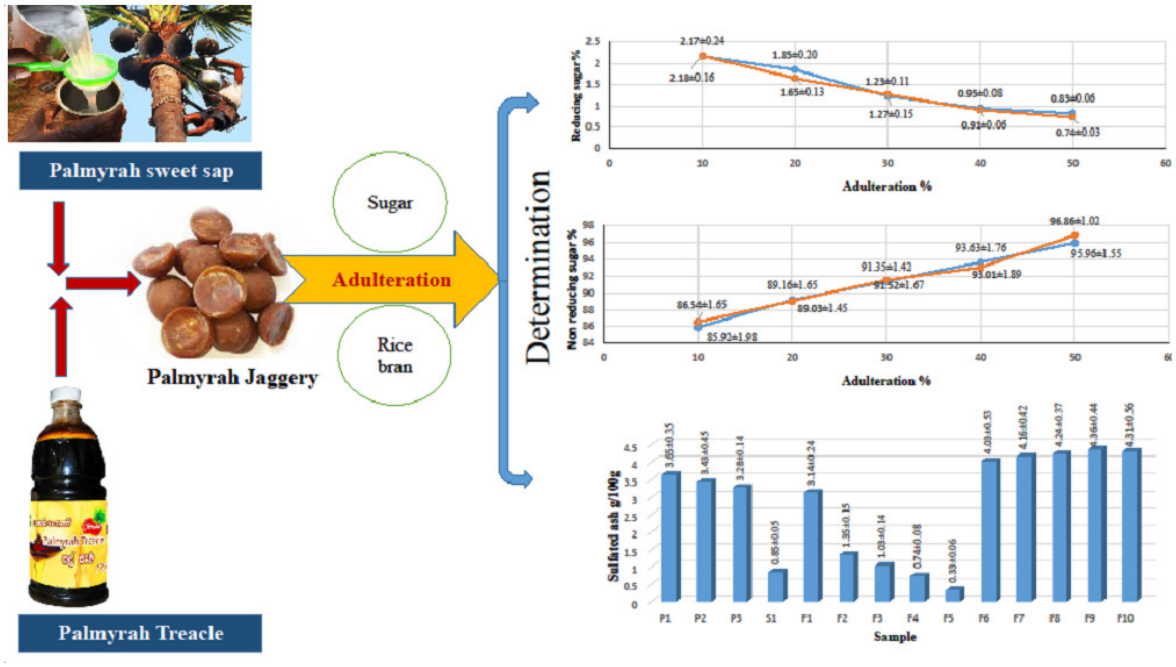
SHORT COMMUNICATION

Comparison of quality and nutritional contents of palmyrah jaggery made from treacle and sweet sap and determination of the adulteration in the marketed samples

T. Glanista*, R. Roxcy, T. Inthuja and S. Srivijeindran



Highlights

- The aim is utilization of palmyrah sap in different forms to make the palmyrah jaggery.
- Determination of quality and nutritional content of jaggery produced from treacle and sweet sap.
- There are some adulterated palmyrah jaggery types available in the local market.
- Physico chemical properties can be used as reliable parameters to identify the adulteration of jaggery.

Ceylon Journal of Science 51(1) 2022: 89-93
DOI: http://doi.org/10.4038/cjs.v51i1.7984

SHORT COMMUNICATION

Comparison of quality and nutritional contents of palmyrah jaggery made from treacle and sweet sap and determination of the adulteration in the marketed samples

T. Glanista[1,*], R. Roxcy[2], T. Inthuja[2] and S. Srivijeindran[1]

[1]Palmyrah Research Institute, Kaithady, Jaffna, Sri Lanka.
[2]Faculty of Animal Science and Export Agriculture, Uva wellassa University of Sri Lanka, Badulla, Sri Lanka.

Received: 19/07/2021; Accepted: 04/02/2022

Abstract: Palmyrah Jaggery is sweet in nature and is produced by concentrating the unfermented inflorescence sap of the palmyrah palm (*Borassus flabellifer L.*). Since, palmyrah sweet sap is seasonal, jaggery is also produced from preserved treacle, during off seasons, to overcome the limitation. Nevertheless, the authenticity of jaggery found in the market is questionable. This study investigates on the quality parameters and selected nutrient contents of palmyrah jaggery produced from fresh sweet sap, preserved treacle and of adulterated palmyrah jaggery. Palmyrah jaggery produced from fresh sap and preserved treacle was in compliance with the requirements of SLS 521:1981. Reducing sugar and non-reducing sugar contents of sweet sap and pure jaggery ranged between 2.15 ± 0.12% to 3.16 ± 0.34% and 77.1 ± 0.50% to 82.2 ± 0.56% respectively, while in the adulterated jaggery the ratio of reducing to non-reducing sugar contents showed variations. The sulfated ash content of pure jaggery was in the range of 3.65 ± 0.35 to 3.28 ± 0.14% while found less in adulterated jaggery. Iron and total phenolic content of pure jaggery were in the range of 11.18 ± 0.05 to 10.33 ± 0.07 mg/100g and 38.84 ± 0.06 to 44.15 ± 0.08 mg/100 g respectively, but was in a lower range in adulterated jaggery. The study concludes that fresh sap preserved in the form of treacle could be successfully used during off season to produce palmyrah jaggery. Acidity, sulfated ash, reducing sugar, non-reducing sugar, total ash and mater insoluble in water, iron and total phenolic content can be used as reliable parameters for identify adulteration of palmyrah jaggery.

***Keywords*:** Palmyrah; sweet sap; treacle; jaggery; adulteration.

INTRODUCTION

The commonly found Asian palmyrah palm (*Borassus flabellifer* L.) belongs to the family Arecaceae**.** Palmyrah palms are widely distributed in the North and East provinces of Sri Lanka and are known to be a valuable economic plant. A number of commercial products made from palmyrah that are available in the local and international markets. Palmyrah jaggery is one of the most popular edible products produced from sweet sap and is one of the ancient and large cottage industries in northern Sri Lanka. It is produced by concentrating the unfermented inflorescence sap of palmyrah palm to a thick consistency in the form of solid blocks. This unfermented fresh sap is called "sweet sap" or "pathaneer". (Theivendirarajah, 2008).

The young, either male or female inflorescences of palmyrah palm produces the fresh sap. The fresh sap is sweet and clear in colour. The sugar content of sap varies from female to male trees. The sap contains mainly sucrose, glucose and fructose as sugars and is also a good source of vitamins; riboflavin, vitamin B12, vitamin C, thiamine, nicotinic acid and minerals; calcium, magnesium iron, zinc, copper and phosphorous. Palmyrah jaggery is also known for its nutritionally functional properties such as an anti-diabetic, anti-hyperglycemic and anti-hyperlipidemic agents (Theivendirarajah, 2008; Suntornsuk *et al.*, 2017). Palmyrah jaggery is a seasonal product and is available during the months of January to June. To make jaggery available throughout the year to the consumers, excess sap is preserved in a concentrated form as treacle, for further processing during the off- seasons.

Consumer demand for palmyrah jaggery has increased with the recognition of its health- promoting factors such as low glycemic index and rich in nutrient content. However, the authenticity of jaggery in the market is questionable. Jaggery is relatively expensive, in comparison to other commercial sugar products. Due to its high demand and price, palmyrah jaggery is often adulterated with cheap adulterants such as cane sugar and rice bran. Adulteration in food is detected by using instrumental techniques such as isotopic ratio chromatography, nuclear magnetic resonance (NMR), and spectroscopy. However, these sophisticated tools are time-consuming, destructive, and expensive. Thus, simple, inexpensive and rapid analytical techniques are needed to detect adulteration. The need to determine the adulteration of palmyrah jaggery using simple chemical tests in the laboratory has been identified (Velauthamurty *et al*., 2014).

Therefore, this study is directed to assess whether the jaggery produced from preserved treacle could retain the same nutrient contents and quality parameters comparable to jaggery produced from fresh sweet sap, benefiting the commercial sales of palmyrah jaggery throughout the year. The study also investigates on the most appropriate quality parameters that could detect the adulteration of palmyrah jaggery sold in the local markets.

**Corresponding Author's Email:* glanista22@gmail.com
https://orcid.org/0000-0001-8981-3347

MATERIALS AND METHODS

Location

This research work was conducted in the Analytical laboratory of Palmyrah Research Institute (PRI), Kaithady, Jaffna, Sri Lanka.

Materials

Palmyrah jaggery samples (authentic recipe and with potential adulterants) were prepared in the analytical laboratory at Palmyrah Research Institute. Pure palmyrah jaggery samples (n=30) were collected from Palm Development Co-operation Societies and potentially adulterated jaggery samples (n=30) were collected from the local market.

Sample preparation

Production of palmyrah jaggery from the fresh sweet sap

Palmyrah inflorescences were tapped in the morning by tappers. Sweet sap was collected in slacked lime treated earthen pots. The cleared sap after lime sedimentation and filtration is transferred into the boiling galvanized iron pan. The pH of the sweet sap was measured. Phosphoric acid was added to maintain the desired pH value of 8.5 - 8.9. The sweet sap was boiled at 60 ℃- 85 ℃. The white scum on the surface when boiling was skimmed off, after 5 min boiling was stopped and allowed to settle. Then clear brown syrup was poured in to boiling pan and boiled at 116 ℃. The concentrated syrup was poured into the molds to be set as jaggery. The process was repeated thrice as three independent samples.

Production of palmyrah jaggery from preserved treacle

Preserved treacle, stored at room temperature (25 – 32 ℃) for five months was collected from marketing unit of Palmyrah Development Board. Treacle was heated in a boiling pan at 116 ℃ for 30 min. The concentrated syrup was poured into the molds to be set as jaggery. The process was repeated in triplicate, as independent samples.

Preparation of adulterated Jaggery in the laboratory

Adulterated jaggery was prepared in the laboratory, similarly to the method used for the preparation of jaggery from fresh pulp, with the addition of a known amount of cane sugar (10.0 g, 20.0 g, 30.0 g, 40.0 g and 50 g of cane sugar to 100 g or mL fresh sap and rice bran (1.0 g, 2.0 g, 3.0 g, 4.0 g and 5.0 g of rice bran to 100.0 g or mL of fresh sap).

Analytical methods

Moisture, Total ash, Matter insoluble in water, Reducing sugar and Non-reducing sugar were determined according to SLS 521:1981). Acidity was determined according to SLS: 729:1985 and sulfated ash content was determined as described by Ramanah *et al*. (2018). The iron content test was carried out according to the Vogel method (Furniss *et al.,* 1989). The total phenolic content was determined by the Folin-Ciocalteu method (Singleton, *et al*, 1999).

The presence of reducing sugar in the jaggery samples were determined by the addition of 2.0 g of jaggery sample to 2.0 mL of Benedict's reagent, heated in a boiling water bath for five minutes and cooled under tap water. Development of green (0.5 to 1%), yellow (1 to 1.5%), orange (1.5 to 2.0%) and red (above 2%) colour indicated the presence of reducing sugar in jaggery samples (Ali, M. S.*et al*, 2018).

Statistical analysis

All data obtained were subjected to statistical analysis (ANOVA), using Minitab 13 software at 95% confidence interval and pairwise compared by using LSD (Least Significant Difference) test. For all the analyses, the alpha error was set at 0.05%.

RESULTS AND DISCUSSION

The moisture content, ash content, % acidity and matter insoluble in water of Palmyrah jaggery samples under study are presented in Table 1.

Moisture content of jaggery produced from fresh sap (5.35 ± 0.25%) and from preserved treacle (5.52 ± 0.45%) was not significantly different ($P > 0.05$). The moisture content for both commercial and laboratory prepared samples with addition of cane sugar or rice bran, varied between 4.17 ± 0.24% to 6.91 ± 0.51%, and were not significantly different ($P > 0.05$). Moisture content of the jaggery is a good index of its storage stability. High moisture content foods are usually susceptible to mold growth and endanger the health of the consumer (Hasanuzzaman *et al*., 2014). All Jaggery samples under study conforms to SLS 521:1981 limits of 10% maximum.

Ash content indicates the total inorganic constituents or minerals present in jaggery. The ash content in jaggery prepared from fresh sap and preserved treacle was not significantly different ($P > 0.05$). The ash content of pure jaggery prepared commercially was in the range of 2.98 ± 0.52% to 3.15 ± 0.10%, respectively. However, the among the samples prepared in the laboratory, those adultered with sugar showed a decrease in the total ash contents in the jaggery, while those samples adultered with rice bran contained a higher amount of total ash contents. Adulterated market samples of jaggery contained the lowest ash content of 0.76 ± 0.04%.

Acidity plays an important role in the stability and storage quality of the jaggery (Mandal *et al*., 2006). The acidity content of palmyrah jaggery (Table 1) produced from preserved treacle and fresh sweet sap was not significantly different ($P > 0.05$). The acidity of pure jaggery was in the range of 0.14±0.03% - 0.18±0.03 %, while that of the jaggery adulterated with sugar (0.047±0.002% - 0.087±0.005%) and rice bran (0.16±0.06% - 0.38±0.09%), was not significantly different at $P < 0.05$.

Matter insoluble in water is determined by the dissolution of the sample in water and subsequent filtration through membrane filters with pore size 0.2 µm. The insoluble matter is then analyzed gravimetrically after

Table 1: Quality characteristics of palmyrah jaggery.

Jaggery samples	No. samples	Moisture content (%)	Ash Content (%)	Acidity (%)	Matter insoluble in water (%)
JS (from pure sap)	03	5.35±0.25	3.15±0.10	0.14±0.03	1.29±0.12
JT (from preserved treacle)	03	5.52±0.45	3.44±0.25	0.18±0.03	1.24±0.10
JS (commercial)	30	5.73±0.54	2.98±0.52	0.17±0.06	1.21±0.11
JSA (adulterated, commercial)	30	6.54±0.35	0.76±0.04	0.084±0.004	0.53±0.09
JS + 10.0 g sugar	03	5.67±0.36	2.94±0.15	0.087±0.005	1.16±0.06
JS + 20.0 g sugar	03	5.92±0.47	1.15±0.12	0.076±0.003	0.94±0.05
JS + 30.0 g sugar	03	5.44±0.46	0.83±0.08	0.07±0.004	0.8±0.05
JS + 40.0 g sugar	03	6.53±0.27	0.56±0.05	0.056±0.002	0.58±0.06
JS+ 50.0 g sugar	03	6.91±0.51	0.16±0.02	0.047±0.002	0.41±0.03
JS + 1.0 g rice bran	03	5.43±0.36	3.93±0.14	0.16±0.06	1.47±0.11
JS +2.0 g rice bran	03	5.15±0.42	3.97±0.24	0.29±0.07	1.53±0.07
JS + 3.0 g rice bran	03	4.89±0.55	4.08±0.45	0.35±0.04	1.59±0.09
JS + 4.0 g rice bran	03	4.65±0.36	4.12±0.31	0.33±0.01	1.67±0.04
JS + 5.0 g rice bran	03	4.17±0.24	4.19±0.35	0.38±0.09	1.87±0.23

JS = Jaggergy from pure sap; JT= Jaggery from stored treacle; JSA= Commercially purchased, potentially adulterated.

the drying of the filters at 105 ℃. This simple technique determines the adulteration in food products and minimizing the adulteration increases the quality of the food product. There was no significant difference between both samples. The SLS521:1981, permits a maximum level of 2.0% of matter insoluble in water, as extraneous matter. The results were decreased with the increase of adulterated with 10, 20, 30, 40 and 50% of filtered sugar solution in sweet sap. Adulterated market jaggery had a very low content of extraneous matter (0.53 ± 0.09%). However, the jaggery samples adulterated with rice bran showed higher matter insoluble in water content ((1.47 ± 0.11% -1.87 ± 0.23%) and was significantly different ($P < 0.05$) compared with that prepared from fresh pulp.

The sulfated ash test is mainly used for determining the content of inorganic matters in organic compounds. The value of sulfated ash content in pure palmyrah jaggery samples was in the range of 3.65 ± 0.35 to 3.28 ± 0.14% and was not significant different ($P > 0.05$) to palmyrah jaggery produced from preserved treacle. In the potentially adulterated market jaggery, the sulphated ash content was 0.85 ± 0.05%, much lower than the jaggery samples prepared from fresh sap. Sulfated ash content significantly decreases with the adulteration of sugar and significantly increase with the adulteration of rice bran. It indicates the possible influence of mineral components of jaggery on sulfated ash content.

Figure 1 and 2 shows that adulteration of jaggery with sugar at different percentages, influence the ratio of reducing to non-reducing sugar contents of jaggery samples respectively. When the percentage of adulteration of sugar increases, the reducing sugar content decreases dramatically and non-reducing sugar increases intensively.

Reducing sugar and non-reducing sugar content of palmyrah jaggery produced from fresh sweet sap was in the range of 2.15 ± 0.12% to 3.16 ± 0.34% and 77.1 ± 0.5% to 82.2 ± 0.6% respectively and was not significantly different from jaggery produced using preserved treacle ($P > 0.05$). The values are respectively 2.18 ± 0.15% to 3.74 ± 0.42% and 79.6 ± 0.4% to 83.7 ± 0.8% . Both jaggery samples comply with SLS521:1981, which permits a maximum of 13% of reducing sugar and 70% of non-reducing sugar in jaggery. The sugar content of jaggery adulterated with rice bran, were within the permitted levels of sugars. Reducing sugar and non-reducing sugar content was 3.90±0.28 % and 79.95±0.73% respectively. The commercial samples of potentially adulterated market jaggery had lower reducing sugar content of 0.83 ± 0.03% and higher non reducing sugar content 93.2 ± 0.8% of than pure jaggery sample, confirming the adulteration of commercial market samples with cane sugar.

In comparison of the nutritional components, palmyrah jaggery had an iron content of 11.18 ± 0.05 and 10.33 ± 0.07 mg /100 g, for those produced from sweet sap and preserved treacle, respectively. Palmyrah jaggery is known to be rich in iron and is an essential element for haemoglobin formation and oxygen transport in humans (Abbaspour *et al*, 2014). The iron content of commercially purchased potentially adulterated market jaggery was 4.56 ± 0.05 mg /100g, much lower than that of jaggery prepared from fresh sap. It was also shown that iron content significantly decreased with the adulteration of sugar and significantly increased with the adulteration of rice bran.

The total phenolic content of jaggery from fresh sap and preserved treacle were in the range of 38.84 ± 0.06 to 44.15 ± 0.08 mg /100g. Phenolics are low molecular weight

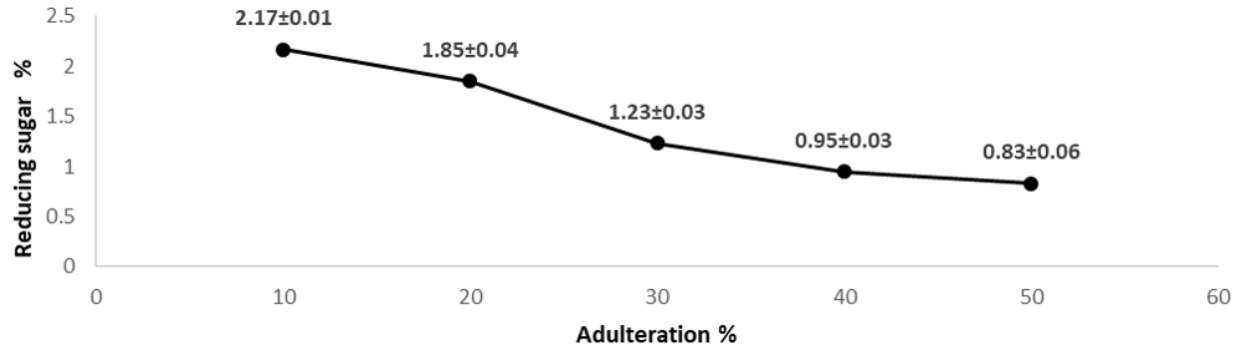


Figure 1: Reducing sugar content of adulterated jaggery samples with sugar.

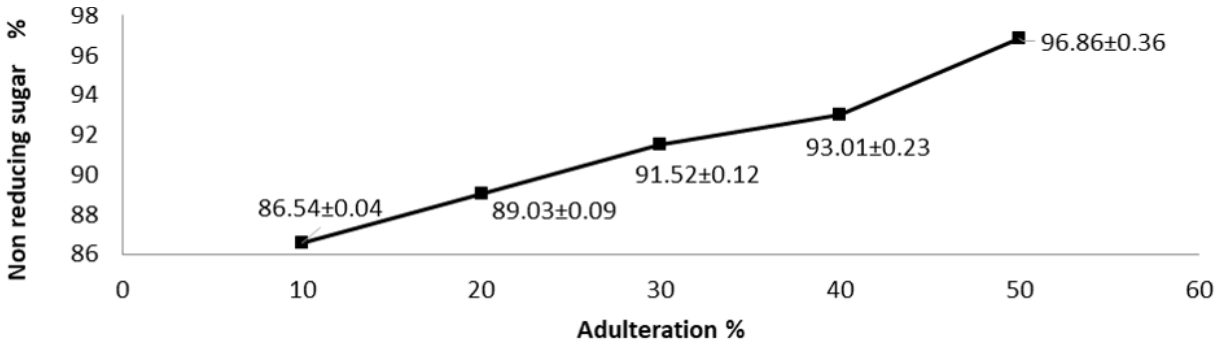


Figure 2: Non-reducing sugar content of adulterated jaggery samples with sugar.

compounds, universally existing in all tissues of higher plants. Their antioxidant properties are well documented and are capable of stabilizing or deactivating free radicals by inhibiting their oxidation before they attack cells. Thus, preventing them from cancer and other chronic diseases (Kurutas, 2015). The phenolic constituent in potentially adulterated samples was 23.36 ± 0.08 mg / 100 g, lower than the pure jaggery, which may have resulted by the adulteration with sugar.

CONCLUSION

Palmyrah jaggery produced from both, fresh sweet sap and preserved treacle comply with the SLS 521:1981. The study confirms that preserved treacle could be used to produce the jaggery in the off season, thus making available the jaggery throughout the year. The study also concludes that sulfated ash content, reducing and non-reducing sugar, total ash, matter insoluble in water, acidity, iron content and total phenol content are reliable parameters to identify the adulteration in palmyrah jaggery.

ACKNOWLEDGEMENT

Authors like to thank the Palmyrah Development Board for the financial support and the Palmyrah Research Institute for providing necessary facilities.

DECLARATION OF CONFLICTS OF INTERESTS

The authors declare no competing interests.

REFERENCES

Abbaspour, N., Hurrell, R. and Kelishadi, R. (2014). Review on iron and its importance for human health. *Journal of research in medical sciences: the official journal of Isfahan University of Medical Sciences*, **19**(2), 164. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3999603/.

Ali, M.S., Quader, M.F.B., Islam, M.A., Ahmed, S., Siddiqua, A. and Akter, T. (2018). Qualitative evaluation of honey available in Bangladeshi markets. *International Journal of Natural and Social Sciences,* **5**(4), 20-27. http://ijnss.org/wp-content/uploads/2018/08/IJNSS-V5I4-4-pp-20-27.pdf.

Benedict, S.R. (1909). A reagent for the detection of reducing sugars. *Journal of Biological Chemistry*, **5**(5), 485-487. DOI: https://doi.org/10.1016/S0021-9258(18)91645-5.

Furniss B.S., Hannaford A.J., Smith P. W. G. and Tatchell A.R.(1989) *Vogel's Text Book of Practical* Organic Chemistry, 325-326, 691-692.

Girish, V., Kumar, K. R. and Girisha, S. T. (2014). Estimation of sugar and bio ethanol from different decaying fruits extract. *Advances in Applied Science Research*, 2014:5: no. 1: 106-110. https://www.imedpub.com/articles/estimation-of-sugar-and-bio-ethanol-from-different-decaying-fruits-extract.pdf.

Hasanuzzaman, M., Nahar, K and Fujita, M. (2014). Role of tocopherol (vitamin E) in plants: abiotic stress tolerance and beyond In: *Emerging technologies and management of crop stress tolerance* (pp. 267-289).

Academic Press. DOI: https://doi.org/10.25177/JPS.5.1.RA.10694.

Kurutas, E.B. (2015). The importance of antioxidants which play the role in cellular response against oxidative/nitrosative stress: current state. *Nutrition Journal*, **15**(1), 1-22. DOI: https://doi.org/10.1186/s12937-016-0186-5.

Ramanah, G., Wimalasena, S., Senadipathi, V., Seniviratne, E. and Suntharalingam, K. (2018). Authenticity testing of coconut toddy samples (Palm Wine) using sulfated ash content. Food *Science and Technology,* **6**(1): 20- 27. DOI: https://doi.org/10.13189/fst.2018.060103.

Suntornsuk, L., Gritsanapun, W., Nilkamhank, S. and Paochom, A (2002). Quantitation of vitamin Ccontent in herbal juice using direct titration. *Journal of pharmaceutical and biomedical analysis*, 28, no.5: 849-855. DOI: https://doi.org/10.1016/s0731-7085(01)00661-6.

Surenther, S., Mahilrajan, S., Chandrasena, G., Robika, K. and SriVijeindran, S. (2017). Effect of Thermal Treatment on Keeping Quality of Palmyrah Sweet Sap. Journal of Dry Zone Agriculture, **3**: 36 – 44. http://www.jdza.jfn.ac.lk/?page_id=119.

Theivendirarajah, K. (2008). *Palmyrah Palm*, A Monograph,K. Theivendirarajah, Roxanne Crescent, Scarborough, Ontario, Canada, **1**: 1-27.

Velauthamurty, K., Mary S., Sashikesh, G. and Srivijeindran S. (2015) "Enhance the quality of palmyrah (*Borassus flabellifer*) jaggery." *Journal of Natural Product and Plant Resources*, **5** (2): 37-42.

Velauthamurty, K., Balaranjan, S. and Sashikesh, G. (2014). A feasibility study for the authentication of palmyrah Jaggery using NIR spectroscopy. *Archives of Applied Science Research*, **6**(6), 55-60. https://www.scholarsresearchlibrary.com/articles/a-feasibility-study-for-the-authentication-of-palmyrah-jaggery-using-nir-spectroscopy.pdf.

Singleton, V.L., Orthofer, R. and Lamuela-Raventos, R.M. (1999). Analysis of totalphenols and other oxidationsubstrates and antioxidants by means of Folin-Ciocalteureagent. *Methodsin Enzymology,* 1999,299: 152-178. DOI: https://doi.org/10.1016/S0076-6879(99)99017-1.

Zábrodská, B. and Vorlová, L. (2014) 'Adulteration of honey and available methods for detection – a review', *Acta Veterinaria Brno*, **83**, pp. S85–S102. DOI: https://doi.org/10.2754/avb201483S10S85.