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THE EFFECTS OF SOAKING TIME ON THE QUALITY AND PROPERTIES OF DURIAN (*Durio zibethinus*) SEED GUM: A MINI REVIEW

(Kesan Masa Rendaman Terhadap Kualiti Dan Sifat Gam Biji Durian (*Durio zibethinus*): Ulasan Mini)

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Abstract

Durian (*Durio zibethinus*) is one of the most notorious fruits in the world, especially in Southeast Asian countries. It is well-known as the "King of Fruits" due to its rich flavour and large size. The unique taste of durian has created its own global demand, which continues to increase despite its unpleasant odour. However, only one-third of the entire durian is consumable, while the seeds and husks are ordinarily disposed of as waste. The seed waste can be potentially converted into value-added products such as seed gum. The high content of carbohydrates and starch in the seeds makes them suitable for use as biopolymers. A natural hydrocolloid can be obtained from durian seeds through a chemical extraction process. This review provides an overview of the effects of different extraction parameters on the physicochemical and functional properties of durian seed gum and discusses the potential application of durian seeds as a food gum. The physical and chemical properties of durian seed gum highly depend on the further extraction parameters and processing of the gum. The findings showed that the soaking process has a greater impact on the quality of the gum produced compared to the concentration of acid used in terms of solubility and water-holding capacity. The physicochemical properties of durian seed gum are comparable to those of commercial food gum, but its anti-nutrient content and sensory evaluation in food products must be further investigated to ensure its safety before consumption.

Keywords: seed waste, chemical extraction, durian seed gum, physicochemical properties

Abstrak

Durian (*Durio zibethinus*) adalah salah satu buah-buahan yang terkenal di negara-negara Asia Tenggara. Durian dikenali sebagai "Raja Buah" kerana ciri-cirinya yang kaya dengan rasa dan mempunyai saiz yang besar. Keenakan dan rasanya yang unik menyebabkan durian telah meraih permintaan yang tinggi di peringkat global walaupun mempunyai bau yang kurang menyenangkan. Walau bagaimanapun, hanya satu pertiga daripada keseluruhan buah durian yang dapat dimakan, iaitu bahagian isinya, manakala biji dan kulitnya biasanya dibuang sebagai sisa kerana dipercayai tiada nilai komersial. Biji durian berpotensi tinggi untuk diolah menjadi produk nilai tambah seperti gam makanan kerana mengandungi karbohidrat dan kanji yang tinggi. Objektif kajian ini adalah untuk menilai pengaruh perbezaan parameter pengekstrakan terhadap sifat fiziko-kimia serta fungsi gam biji durian dan menilai potensi penggunaan biji durian sebagai penstabil makanan. Ciri-ciri fizikal dan kimia gam biji durian bergantung pada parameter pengekstrakan dan pemprosesan yang lebih lanjut. Hasil kajian menunjukkan bahawa proses rendaman mempunyai kesan yang lebih besar terhadap kualiti gam yang dihasilkan dibandingkan dengan kepekatan asid yang digunakan dari segi kelarutan dan kapasiti pengekalan air. Ciri-ciri fiziko-kimia gam biji durian adalah setanding dengan gam makanan yang terdapat di pasaran, tetapi kandungan anti-nutrien dan penilaian berderia dalam produk makanan perlu dikaji dengan lebih mendalam untuk memastikan keselamatannya sebelum digunakan dalam pemakanan.

Kata kunci: sisa biji benih, pengekstrakan kimia, gam biji durian, sifat fizikokimia

Introduction

Durian (*Durio zibethinus*) belongs to the Bombacaceae family and is the most popular seasonal fruit in Southeast Asia, especially Thailand, Malaysia, the Philippines, and Indonesia. In 2019, the national production of durian increased tremendously due to its great demand on the global stage, such as China, Vietnam, Singapore, and the United States [1]. During the breakdown of the COVID-19 pandemic, between March and May 2020, the reported sales of durian in Malaysia had reached one tonne per day [2]. However, only one-third of the entire durian is consumable, while the seeds (20–25%) and the husk are ordinarily disposed of. For example, the Philippines, a country in Southeast Asia, faces a problem with the large amount of durian waste produced every year. According to Ana et al., about 40% of durian husks, including 25% of durian seeds (21,880), are considered waste in the Philippines annually [3]. Furthermore, in the first half of 2018, around 4000 tonnes of durian seeds were discarded in Singapore [4]. Subsequently, extensive research has been conducted on the growth of value-added products to reduce the wastage from the inconsumable part of durian. Mirhosseini and Amid stated that the unused durian seeds have great potential to be produced as value-added goods, such as flour and stabilisers, as they contain a high amount of carbohydrates, fibre, and vitamins [5].

Generally, durian seed gum can be obtained through a chemical extraction process as it produces a higher quality of gum compared to the aqueous extraction process. This is because the aqueous extraction process produces gum with a higher moisture content, which indirectly affects the shelf life of the gum produced. The difference in extraction parameters, such as soaking time, soaking temperature, and decolourisation time, was reported to have affected the physicochemical properties of the gum produced. Meanwhile, purification methods also affect the functional characteristics of durian seed gum [6]. Although there has been plenty of research conducted globally on the production and application of durian seed gum, much improvement is still required for a larger yield and better properties of the gum.

Based on current knowledge, the effects of acetic acid concentration and soaking time on the physicochemical properties of durian seed gum have not been fully investigated. Therefore, the present study aims to review the effects of acetic acid concentration and soaking time, especially on the physicochemical and functional properties of durian seed gum, and to explore the potential application of durian seeds as food gum. This study also intends to provide an overview and future perspective on the use of durian seeds in resolving the global food waste issue faced by Asian countries over the years. Converting food waste into useful products not only helps to reduce agricultural waste, but also helps to minimise environmental pollution [7].

Overview of food gum

Food gum, also referred to as natural hydrocolloid, is commonly used in food manufacturing as thickeners, gelling agents, stabilisers, coating agents, and packaging film. Gum is a complex polysaccharide that can be obtained from various sources, such as seaweed extract (e.g., agar), the endosperm of plant seeds (e.g., guar gum), and bacteria (e.g., xanthan gum). According to Clemens and Pressman, food gum consists of carbohydrates with a large number of hydroxyl groups, resulting in hydrophilic characteristics [8]. Therefore, food gums are highly water-soluble due to their polymers that form a cross-linked network by trapping and immobilising water in a viscoelastic, flow-resistant structure. One of the common functional properties of hydrocolloid is their thickening properties, which determine the viscosity of the gum produced. According to Phillips and Williams, the viscosity of the gum is significantly influenced by the molecular mass of the polymer [9]. The higher the molecular mass, the more viscous the gum produced. The next functional properties of food gum are emulsification properties. Golkar et al. reported that the emulsification properties of food gum are affected by its interfacial activity, which stabilises and forms oil droplets in emulsions [10].

Other functional properties of food gum are hydration and solubilisation. All polysaccharides have sections in their solid state where the chain segments or molecules are disordered and unorganised. As a result, these amorphous regions have a large number of unfulfilled hydrogen bonding spots that can easily hydrate [9]. Polysaccharides that are entirely dry have a slow but extremely significant affinity for water. When a soluble polysaccharide is immersed in water, the numerous water molecules directly enter amorphous regions and attach to accessible polymer sites. Subsequently, the number of other inter-polysaccharide linkages can be minimised. The inter-polysaccharide bonds are broken down by kinetic action and result in the full solubility of the polysaccharide chain.

Generally, polysaccharides can be found in four common structures: linear, single-branch, substituted linear, and branch-on-branch [1]. Figure 1 shows the different types of polysaccharide polymer structures. Glicksman stated that the solution of branched polysaccharides is more stable than the solution of a linear molecule [1]. The solution with branched molecules remains homogenous for a long period of time due to its high affinity for water and good adhesive properties. Durian seed gum exemplifies good adhesive properties as it is composed of branched molecules [5].

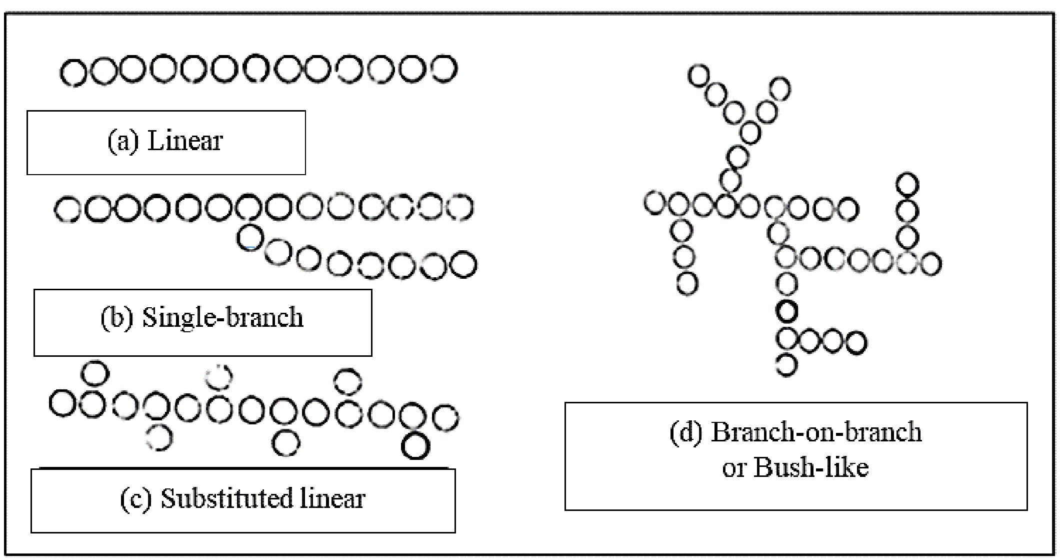

Figure 1. The types of polysaccharide polymer structures [1]

Potential application of durian seeds as food gum

The durian seed contains a high level of polysaccharides suitable for being used as gum for thickening and gelling properties [11]. The protein content of durian seeds is estimated to be 3.40%, the moisture content to be 54.90%, the starch content to be 18.92%, and the fat content to be 1.32% [12]. Amin et al. studied the composition of durian seed gum for the dehulled and whole durian seed flour. The study found that the entire durian seed flour contains 6.0% protein, 0.4% fat, 3.1% ash, 10.1% crude fibre, 73.9% carbohydrates, and 6.0% water [13]. Meanwhile, dehulled durian seed flour contains 0.4% fat, 3.8% ash, 7.6% protein, 4.8% crude fibre, 76.8% carbohydrates, and 6.6% water. The high carbohydrate content in both types of durian seed flour makes them suitable to undergo further processing due to their excellent thickening properties. Amin et al. stated that the durian seed gum is stable at pH levels between 2.0 and 10.0. This pH is similar to the pH of xanthan gum (2.0 to 12.0) and further supports their application in a wide range of products [13].

In addition to this, the three primary sugars in durian seed gum are rhamnose, D-galactose, and glucose. Amin et al. found that the ratio of these sugars (i.e., glucose, rhamnose, and D-galactose) is 9:3:1, respectively [13]. The primary component in the formation of gum in durian seeds is L-rhamnose, which is also known as C-5 polysaccharide. When rhamnose sugar comes into contact with water, polysaccharides form a structure to prevent water molecules from joining. As a result, a thicker gel is formed after the detraction of water molecules by C-5 polysaccharide [14]. Therefore, the presence of sugar in the polysaccharide is important in enhancing the rheological properties of the gum, which are dependent on the soaking and purification process [15]. Moreover, the durian seed gum is comparable to guar gum in terms of colour, solubility, water, and oil-holding capacity [2]. The study revealed that the solubility of durian seed gum is higher than that of guar gum due to its active interaction between protein and monosaccharide fractions. Apparently, the colour of durian seed gum is slightly darker compared to the colour of guar gum (Figure 2), but it is acceptable.

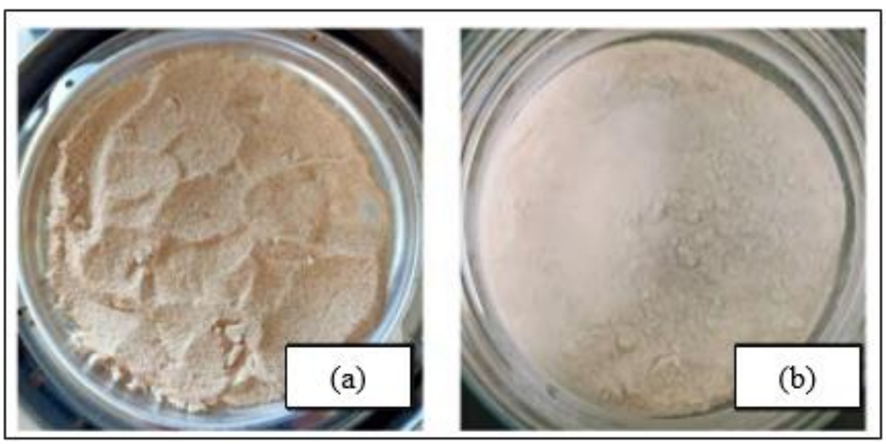

Figure 2. (a) Durian seed gum; (b) guar gum [2]

In another study, Cornelia et al. described that the use of durian seed gum as an emulsifier in vegan mayonnaise results in the same texture as commercial vegan mayonnaise [11]. Furthermore, there is no significant cream helps to improve the consistency and texture of the ice cream. This is proven when the overrun of the ice cream at a low concentration (0.1%) of durian seed gum difference in terms of aroma in vegan mayonnaise made from durian seed gum. The application of durian seed gum in ice cream was investigated by Sawasdikarn et al. and found that the use of durian seed gum in sherbet ice was higher (30.26%) compared to the overrun of ice cream without any durian seed gum (25.36%) [16].

Effects of extraction parameters on the properties of durian seed gum

The processing steps involved in producing durian seed gum include extraction and purification phases. As shown in Table 1, different researchers have used different ranges of extraction parameters (soaking time, soaking temperature, decolouring time, and concentration of acid and pH). Sompie et al. reported that prolonging the soaking time in the presence of heat during the extraction process opens up the bonds of gelation molecules, thus resulting in a higher yield [17]. This finding is supported by Veira et al. that a temperature of 60°C produced a high yield of flaxseed gum [18].

Besides that, the hydration properties of the gum also depend on the water-holding capacity (WHC), solubility, and swelling capacity [5]. The interaction of soaking time and soaking temperature represents the most significant effect on the WHC of the gum as compared to the decolourisation process. The WHC of gum is determined by the conformational structure, pore size, and capillary of the molecule that are associated with the hydration molecule with polar compound and hydrophilic interaction [19]. According to Mirhosseini and Amid, gum extracted below 85°C with an alkaline pH has a higher WHC [6]. Besides, the interaction of soaking time and soaking temperature represents the most significant effect on the WHC of the gum compared to the decolourisation process. This is because the swelling properties of the gum generally depend on the ratio between the solvent and matrix, soaking time, and soaking temperature. The longer soaking time results in lower WHC properties because it has a poor affinity for absorbing water. Therefore, a shorter soaking process is required as it leads to a smaller pore size of the gum and thus increases the WHC. In contrast to the WHC, the lower soaking temperature and longer decolourisation produce a gum with a higher oil-holding capacity (OHC). High OHC is associated with a hydrophobic character and the presence of non-polar amino acids. According to Mirhosseini and Amid, purified gum has lower OHC than crude gum due to the presence of hydrophobic fractions and non-polar side chains in the crude durian seed gum that may bind the hydrocarbon units of oil [6].

Generally, gum exhibits high solubility and relatively low viscosity. Sompie et al. reported that the presence of heat during the soaking process may help in forming gum with higher viscosity properties, but eventually reduces them at higher temperatures [17]. According to Viera et al., the soaking process at 60 °C is sufficient to produce gum with a high viscosity. This is because the heat opens up the bonds between molecules and free-flowing liquids that are initially trapped inside the structure, thus forming a viscous gel [18].

Besides that, the solubility of a polymer in a solution depends on the size and weight of molecules as well as the concentration of the polymer in the solution. A study found that gum soaked for 4 to 8 hours has low solubility properties [5], but the finding is contradictory. A study conducted by Akdowa et al. found that the gum undergoes a one-to-three-hour soaking process to have better solubility properties [20], while the study by Batal and Hasib reported that one hour of the soaking process is sufficient to produce gum with high solubility properties [21]. The study found that the longer the soaking process, the larger the particle size of gum. Figure 3 shows a simple illustration of the effects of soaking time on the particle size of gum produced. A shorter soaking process results in a smaller particle size due to the lower absorption of insoluble matter into the final extract.

According to Mirhosseini and Amid, gum with high impurities and larger molecules has lower solubility properties [5]. This is because coarser and larger particles require a longer time to be dissolved due to the longer time required to penetrate water into the sample matrix. Therefore, the soaking time is crucial in producing a high-quality durian seed gum as it helps to reduce the protein content, ash content, and insoluble impurities. Generally, a shorter soaking process is preferable as it results in the presence of small gum particles and better solubility of gum.

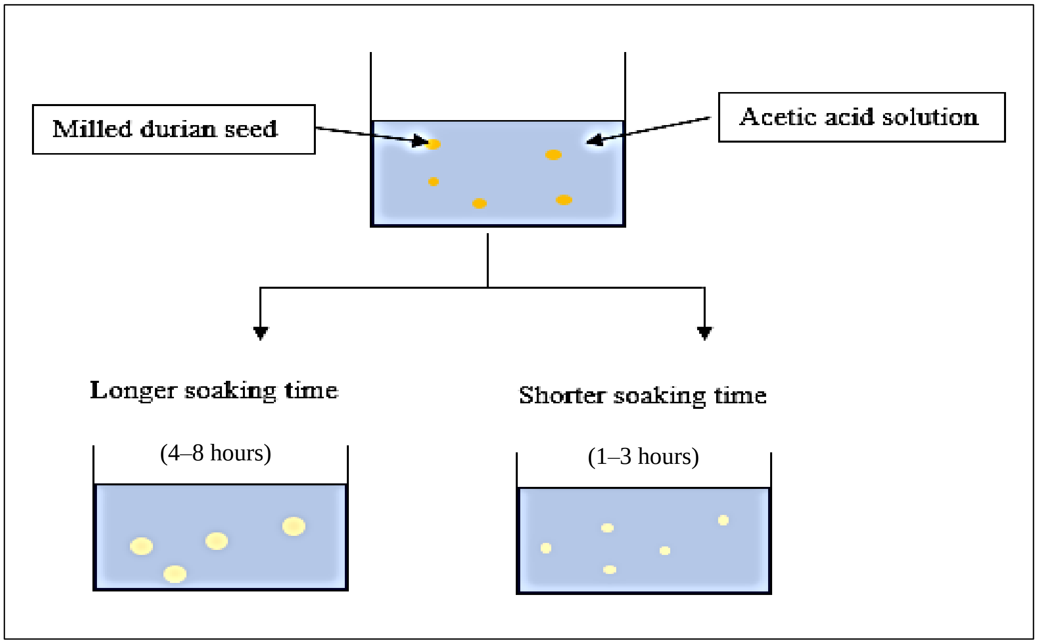

Figure 3. Illustration on the effects of soaking time on the particle size of gum produced

Apart from that, protein content in gum is also a known factor in affecting the purity of the gum. Gum with large amounts of protein is more flexible and has good adsorption capacity at the interface. Therefore, the protein content of the gum is highly critical toward achieving a good emulsifier property. According to Sompie et al., the acid concentration used during extraction influences the protein content of the gum produced [17]. The study showed that 4% of acid is good for producing gum with excellent emulsifying properties. Meanwhile, a high concentration of acid used reduces the viscosity of the gum due to the destruction of protein structures (hydrolysation of the peptide bond). Another work by Akdowa et al., which employed 1% of acetic acid, was also able to produce viscous gum coupled with a proper soaking process during the chemical extraction [20]. The suitable range of acetic acid concentration is between 1% and 4%, because at these concentrations, the peptide bond in the molecules cannot be broken down. Thus, high viscosity gum can be produced. However, a 1% concentration of acetic acid is preferable as it is less acidic and toxic.

Table 1. Different ranges of extraction parameters for durian seed gum.

Ref.	Parameters					Findings / Properties of Gum Obtained
	Temperature (℃)	Soaking Time (hr)	Decolouring Time (hr)	Concentration of Acid (%)	pH	
[5]	25℃ – 55℃	4 hrs – 8 hrs	1 hr – 3 hrs	1%	N/A	• Low solubility and WHC properties • Soaking time should be considered as the most critical extraction variable
[17]	50℃ – 60℃	N/A	N/A	2% – 6%	N/A	• Strong gel strength • Higher concentration causes a decrease in viscosity • Optimum condition: 4% of acetic acid at 55℃
[20]	N/A	1 hr – 3 hrs	N/A	1%	4 – 10	• Good solubility properties • Optimum condition: 1 hour; pH 7
[21]	70℃ – 100℃	20 mins – 60 mins	N/A	1%	N/A	• Maximum yield of gum • Optimum condition: 95℃ for 60 minutes

Challenges of durian seeds as food gum

Despite the merits of durian seeds as food gum, some challenges still arise. First, the amount of anti-nutrients in durian-derived seed gum is higher compared to that of other types of gum. According to Marina et al., the amount of anti-nutrients such as tannins, saponins, phytates, and oxalates was 232.19±4.92 mg/100g, 60.22±1.27 mg/100g, 181.32±4.46 mg/100g, and 105.55±13.07 mg/100g, respectively, after the durian seed underwent the boiling process [22]. These values were much higher than the amounts found in acacia seeds and karaya (3.0 mg/100g and 3.5 mg/100g) [4].

Next, food products require more durian seed gum than other commercial gums. For example, vegan mayonnaise requires at least 4% of durian seed gum to achieve a preferable texture [11]. Apart from that, additional usage of other commercial gums such as Arabic gum or xanthan gum is required if the concentration of durian seed gum used is lower than 4%. As a result, if manufacturers are forced to double or triple the quantities of stabilisers used in their products, production costs may rise. Besides that, research on the sensory properties of food using durian seed gum is less reported and lacking. To date, there have only been two available studies that focused on mayonnaise [11] and ice cream [16]. Inadequate sources of information are a limitation for further studies on the application of durian seed gum as a potential food ingredient.

Finally, the nature of the durian's growth, which belongs to the seasonal fruit category, might be a drawback to its continuous production. Commonly, the fruiting season of durian in Malaysia is from June to July. In order to ensure the availability of durian seed gum, the seeds must be handled with extra care during the fruiting season. Improper storage of the seeds may result in the loss of viability, which may reduce their moisture content and their overall quality [23].

Conclusion

To sum up, the soaking process has a significant impact on the properties of durian seed gum compared to the concentration of acid used during the extraction process. This is because the soaking time affects the quantity of impurities present in the gum and the particle size of the gum extracted, which have a direct impact on the solubility and water-holding capacity of the gum. Nevertheless, the selection of the extraction parameters depends on the purpose of the extracted gum. If the physicochemical and functional properties of the gum are targeted, a soaking time of 1 to 2 hours is sufficient. Meanwhile, a longer soaking time is needed if the gum yield is targeted. The ideal range of soaking temperatures is between 55°C and 95°C. Further research on anti-nutrient content and sensory evaluation of durian seed gum in food products is needed for safety purposes. It is also beneficial to analyse the nanoparticles of durian seed gum to improve its solubility, thus producing food gum of better quality.

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References

1. Glicksman, M. (2020). *Food Hydrocolloid* (1st ed.). CRC Press Publisher.
2. Syamila, M., Hikmah, A.R., Zaiton, H. and Radhiah, O. (2020). Comparative study on the absorption and solubility properties of durian seed gum and commercial guar gum. Retrieved from https://oarep.usim.edu.my/jspui/handle/123456789/6888.
3. Ana, M.E., Carmen, S., María, L.E., Berta, E., Sandra, E. and Cristian, S. (2004). Extraction methods and some physical properties of mesquite (*Prosopis chilensis (Mol) Stuntz*) seed gum. *Journal of the Science of Food and Agriculture,* 84(12): 1487-1492.
4. Hamdani, A. M., Wani, I. A., Bhat, N. A. and Masoodi, F. A. (2018). Chemical composition, total phenolic content, antioxidant and antinutritional characterisation of exudate gums. *Food BioScience*, 23: 67-74.
5. Mirhosseini, H. and Amid, B.T. (2012). Effect of different drying techniques on flowability characteristics and chemical properties of natural carbohydrate-protein gum from durian fruit seed. *Chemistry Central Journal*, 2013: 7
6. Mirhosseini, H. and Amid, B. T. (2012). Influence of chemical extraction conditions on the physicochemical and functional properties of polysaccharide gum from durian (*Durio zibethinus*) seed. *Molecules*, 17(6) : 6465-6480.
7. Khalaf, A., Desa, S. and Baharum, S. (2019). Overview of selected native seeds in agricultural wastes and its properties. *Medico-legal Update,* 19(2): 324-330.
8. Clemens, R. and Pressman, P. (2017). Food gums: An overview. *Nutrition Today,* 52(1): 41-43.
9. Phillips, G. and Williams, P. (2020). *Handbook of Hydrocolloids* (3rd ed.). Woodhead Publishing.
10. Golkar, A., Taghavi, S. M. and Dehnavi, F. A. (2018). The emulsifying properties of Persian gum (*Amygdalus scoparia Spach*) as compared with gum Arabic. *International Journal of Food Properties,* 21(1): 416-436.
11. Cornelia, M., Siratantri, T. and Prawita, R. (2015). The utilization of extract durian (*Durio zibethinus L.*) seed gum as an emulsifier in vegan mayonnaise. *Procedia Food Science,* 3: 1-18.
12. Srianta, I., Hedrawan, B., Kusumawati, N. and Blanc, P. J. (2012). Study on durian seed as a new substrate for angkak production. *International Food Research Journal,* 19(3): 941-945.
13. Amin, A. M., Ahmad, A. S., Yin, Y., Yahya, N. and Ibrahim, N. (2007). Extraction, purification, and characterization of durian (*Durio zibethinus*) seed gum. *Food Hydrocolloids,* 21(2): 273-279.
14. Navaratne, S. B and Nawarathne, N. H. N. T. (2014). Determination of suitability of durian seed gum extract (*Durio zebethinus*) in replacing of xanthan gum in fruit nectar. *International Journal of Scientific Engineering and Research,* 2(2): 86-89.

15. Amid, B., Mirhosseini, H. and Kostadinovic, S. (2012). Chemical composition and molecular structure of polysaccharide-protein biopolymer from *Durio zibethinus* seed: extraction and purification process. *Chemistry Central Journal*, 6: 117.
16. Sawasdikarn, J., Nilanon, W. and Suwannarat, Y. (2017). Characterization of gum from durian seed an application in ice cream. *International Journal of Agricultural Technology*, 13(7): 2661-2667.
17. Sompie, M., Surtijono, S. E., Pontoh, J. H. W., and Lontaan, N. N. (2015). The effects of acetic acid concentration and extraction temperature on physical and chemical properties of pigskin gelatin. *Procedia Food Science,* 3: 383-388.
18. Vieira, J. M., Mantovani, R. A., Raposo, M. F. J., Coimbra, M. A., Vicente, A. A. and Cunha, R. L. (2019). Effect of extraction temperature on rheological behavior and antioxidant capacity of flaxseed gum. *Carbohydrate Polymers,* 213: 217-227.
19. Shad, M. A., Nawaz, H., Hussain, M. and Yousuf, B. (2011). Proximate composition and functional properties of rhizomes of lotus (*Nelumbo nucifera*) from Punjab, Pakistan. *Pakistan Journal of Botany*, 43: 895-904.
20. Akdowa, E. P., Boudjeko, T., Woguia, A. L. and Njintang N. Y. (2014). Optimization of variables for aqueous extraction of gum from grewia mollis powder. *Journal of Polymers,* 2014: 1-10.
21. Batal, H. E. and Hasib, A. (2013). Optimization of extraction process of carob bean gum purified from carob seeds by response surface methodology. *Chemical and Process Engineering Research,* 12: 1-8
22. Marina, Z., Noriham, A., Noorlaila, A. and Azmi, M. N. (2016). Influence of thermal processing on chemical composition and antinutritional factors of durian (*Durio zibethinus*) seed. Retrieved from https://ir.uitm.edu.my/id/eprint/26756/.
23. Selvi, D. T. and Saraswathy, S. (2017). Seed viability, seed deterioration and seed quality improvements in stored onion seeds: A review. *Journal of Horticultural Science and Biotechnology,* 93(1): 1-7.