Production of Gummy Confection using Seeds Gum from *Durio zibethinus* Seeds

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**Abstract.** Durian is the most popular seasonal fruit in Malaysia. Only one-third of durian is edible, whereas the seeds are thrown away. This waste is potential of value-added such as seed gum. In this research, durian seed gum has been used to replace commonly used mammalian gelatine as gelling agent in making gummy confection. Several formulations consisting different compositions of gelling agent durian seed gum: fish gelatine (100:0; 75:25; 50:50; 25:75; 0:100) have been used. Experimental design was divided into two stages, preliminary and the main research. Preliminary research was conducted to produce gum extract from durian seed using different solvents. The main research was to determine the best formulation on making of gummy confection with the presence of gelatine, sucrose, glucose syrup, ascorbic acid, and pineapple juice as gel stabilizer and flavour enhancer. Selected formulation (durian seed gum: fish gelatine; 75:25) based on texture analysis and sensory test were being compared to commercial gummy confection in the market. Again, prepared gummy confection using composite durian seed gum and gelatine has better properties in terms of hardness, texture, gumminess, and overall sensory acceptance compared to individual durian seed gum and individual gelatine confection. Hence, prepared gummy candy showed good potential in the development of various types of gummy confections using waste materials, preserving nutritional values of durian origin, as well as rejecting the halal issues and bovine spongiform encephalopathy (BSE) disease regarding mammalian gelatine.

1. **Introduction**

Durian (*Durio zibethinus* L.; Family *Bombacaceae*) are native to Malaysia and the Southeast Asian countries. It is nominated by the locals as ‘king of fruits’ in Malaysia because it is the most highly prized fruit in Malaysia. The unique characteristics of this food is it has high volatile sulphur compounds. Only flesh part (also called aril) of the durian fruits is considered edible and sometimes fermented with salt. Its seed presents in light brownish color and has chestnuts like structure with length and diameter of 2-6cm, and 2-3 cm respectively. [1].

Nowadays, we can notice that most of the Malaysian likes to eat durian but they left behind a lot of durian seeds after eating the durians. Only one-third of the durian is edible, whereas the seeds (20-25%) are mostly thrown away after the consumption. Therefore, this crop waste can be significant potential source of raw material useful for the development of value-added products such as seed gum, flour and so on [2]. Natural plant gums are usually safe for oral consumption and are preferred over...
analogous synthetic gums due to their safety (non-toxic), low cost and availability [3]. Actually, we can utilize the durian seeds to produce something useful because of its viscid texture and it contains a lot of nutrients. Examples of nutrients that we can find in durian seeds are fibre, zinc, vitamin C, vitamin B6, manganese, potassium, magnesium and phosphorus. Based on these nutrients, durian seeds can provide a lot of benefits such as regulating blood sugar levels, promotes healthy skin, fights depression, avoids constipation and maintains healthy bones [4]. It has been proven that durian seed gum has the ability to stabilize oil in water emulsions. Durian seeds are not advised to be eaten raw because it may be poisonous, but they still can be eaten and they are very palatable when they’re boiled, roasted, or fried in coconut oil. After the seeds are boiled, fried or roasted, they will have a texture that is similar to yam, but stickier [5, 6].

Gummy confectionery, or better known as gummy candy are broad category of gelatin-based, chewable sweets. Among protein-based gelling agents, mammalian gelatin has been used in manufacturing jelly confectionery due to its diverse functional properties, especially its textural, gel-forming, foam-stabilizing and emulsifying properties [7]. However, mammalian gelatin obtained from bovine or porcine sources is undesirable to vegetarian population and certain ethnic groups [8].

Fish gelatin has been used as an alternative to mammalian gelatin in recent years but its utilization is still limited due to limited access to fish skins among filleting company. Apart from this, durian seed gum has specific structure which allow intermolecular bonding with other substance due to its great compatibility for various functionalities [9]. Hence, durian seed gums could be used as the new alternative to replace gelatin in the preparation of gummy confections as the gelling agent and could be potentially marketed in the future.

Bio-polymeric materials such as seed gum (SG) can serve as good natural sources for gummy confection forming material as alternatives to the present commercial mammalian gelatin. These materials have good gel forming properties, acceptable to all religions and vegetarians, and free from viruses and prions contamination like bovine spongiform encephalopathy (BSE) and foot-and-mouth disease (FMD). Apart from this, durian seed gum has specific structure which allow intermolecular bonding with other substance due to its great compatibility for various functionalities [9]. Due to great potential of biocompatibility of both biopolymers, durian seed gum-fish gelatin (SG-FG) mixtures could be good alternative material in the preparation of gummy candy confection.

The purpose of this research is to investigate that whether the durian seeds are suitable to produce gummy confection instead of using gelatine or chemical substances such as xanthan and carrageenan as a thickening agent in the making of gummy confection. In any commercial scale of fruit processing industry, durian seed gum can be used as a thickening agent [2]. The mineral content of durian seed gum was comparable to commercial gum except for zinc content which was quite high in durian seed gum. In fact, there are low amount of the protein fraction (3.2–3.9%) presence in the chemical structure of the biopolymer from durian seed [10]. The most abundant and predominant chemical composition and molecular structure of durian seed gum are carbohydrate, fatty acid and amino acids [2]. Since, durian seed is enriched with lots of nutrient, it will be a productive option to produce gummy confection that will not bring harm to our body health because durian seeds are a waste product and completely discarded after consuming the edible flesh.

Gelatine is the main material that gives the gummy confection its characteristic properties such as good flavor release, memory and a clear, translucent appearance [11]. In gelatine and high-methoxyl pectin, the hardness, gumminess and Young’s moduli of gummy confection decreased significantly with increasing water content and red pitaya fruit puree (RPFP; Hylocereus polyrhizus), implying a marked decrease in rigidity and formation of flexible polymer gel networks [12]. The results from texture profile analysis tests showed that in the formulation of gummy confections, the addition of acid modified corn starch to gelatine gels in suitable proportions can be a feasible alternative [13]. In the invention of gelatine-free gummy confection using gellan gum and carrageenan, the best result produced is using 2.5% carrageenan and 0.25% gellan gum E418 [14]. There are two types of gelatin. The primary sources of gelatine are from bovine animals and pigs which causes the religious ramifications arise. Other sources of gelatine are made from beef, fish or birds and this have been
indicated in the literature as alternative, small volume sources of gelatine. However, these sources of gelatine providing the possible link to bovine spongiform encephalopathy, BSE, or “Mad Cow Disease” in the United Kingdom [11]. In the gummy confectionery product, mostly contain oxidized starch, optionally in combination with a gum such as gum arabic, as a replacement for at least a part and preferably all of the gelatin in the product [7].

2. Methodology
Experimental design was divided into two stages, preliminary and the main research. Preliminary research was conducted to produce gum extract from durian seed using different solvents. The main research was to determine the best formulation on making of gummy confection with the presence of gelatine, sucrose, glucose syrup, ascorbic acid, distilled water, and pineapple juice as gel stabiliser and flavour enhancer.

2.1. Extraction of Durian Seed Gum
Sample durian (Durio zibethinus) was collected from the Malaysian local market. Ripened and free of visual defects durian fruits were selected. The fruits were then de-husked, by cutting along the suture on the back of the durian. The durian flash was removed and the seeds was collected, cleaned and rinsed with deionized water. The seed was partially dried by the air circulation at the room temperature for one night. The skin of the seeds was peeled and the durian seeds were chopped into small sizes and dried in a cabinet dryer for 24 - 48 hours (50 °C). The seeds were mixed and sieved with 80 mesh sieve to make seed flour. The durian seed flour was extracted by using demineralised water for 1 hour and the extract were centrifuged for 10 minutes. The sediment was mixed with 96% ethanol (2 times of the supernatant) and dried for 12 hours. The extraction was being blended and sieved using a 120 mesh sieve. Preparation flow diagram of gum durian seed can be seen as Figure 1, while Figure 2 shows the final product of dried durian seed gum. The viscosity profiles was analyzed using rheometer anton paar at 25°C.

![Flow diagram of making gum extract from durian seed](image)

**Figure 1.** Flow diagram of making gum extract from durian seed [5].
2.2. Preparation of Gummy Confection

Gummy confections were prepared as shown in Figure 3 using durian seed gums and fish gelatin as gelling agents. Briefly, the durian seed gum and fish gelatin were solubilized in distilled water at 60 °C for 15 minutes at various weight percentage ratios of durian seed gum to fish gelatin (100:0; 75:25; 50:50; 25:75; 0:100). Subsequently, sucrose (36.6%, w/w) was dissolved in the mixture, before adding glucose syrup (24.4%, w/w) and ascorbic acid (0.05%, w/w). Pineapple juice (3.9%, w/w) was also added as gel stabilizer and flavor enhancer in the gummy confections. Prior to molding, the mixtures were heated further until the resultant mixture reached final soluble solid content. The final mixture was then allowed to cool and set. The gummy confections prepared from gelatin incorporated with durian seed flour was referred to as Gelatin Gummy Confection (GGC). GGC samples were kept at room temperature (25 °C) until further analysis. The best formulation of confection produced was compared to the commercial gummy candy in the market using the same parameters. Then, the products were tasted by the participants.

Figure 3. Flow diagram of preparation of gummy confections incorporated with durian seed flour.
2.3. Formulations for Gummy Candy Confectioneries

Each formulation in Table 1 were prepared in triplicates (n = 3), total (n = 15).

| Formulation | Sample  | Ratio of gelling agent (total gelling agent = 25% w/w total mixtures) | Additives, stabilizers, and water (75% w/w total mixtures) | Total mixtures (%) |
|-------------|---------|---------------------------------------------------------------------|------------------------------------------------|-------------------|
|             |         | Durian seed gum (%) | Fish gelatin (%) | Sucrose (36.6%) | Glucose syrup (24.4%) | Ascorbic acid (0.05%) Pineapple juice (3.9%) | Water (10.05%) | 100 |
| 1           | SG100   | 100                  | 0               |                |                        |                                               |
| 2           | SG75FG25| 75                   | 25              |                |                        |                                               |
| 3           | SG50FG50| 50                   | 50              |                |                        |                                               |
| 4           | SG25FG75| 25                   | 75              |                |                        |                                               |
| 5           | FG100   | 0                    | 100             |                |                        |                                               |
| 6           | Commercial | -                  | -               |                |                        |                                               |

Figure 4. Gummy confection product with different ratio of seed gum: gelatin.

2.3.1. Hardness of Gummy Candy

The hardness was determined using Shimadzu Texture Analyzer. A puncture test method with needle probe was used to determine the sample hardness. The peak force obtained, in newton was taken to be the result from the test.

2.3.2. Color of Gummy Candy

The color of extracted powder was examined using chroma meter (Minolta, Japan). The color was evaluated by means of CIE Lab color components (L*; lightness, a*; redness and b*; yellowness) [15]

2.3.3. Preference test of Gummy Candy

The sensory test was participated by 30 participants. The attributes tested was taste, hardness, aroma, gumminess and potential to buy. Each participant will choose the most preferred attributes among the gummy candy samples.

3. Results and Discussion

3.1 Viscosity of durian seed gum extract

The viscosity value for the durian seed gum extract is 0.1112 Pa.s (Pascal-second), which is about 100 times the viscosity of water. This was due to the high molecular weight of seed gum. The long polymeric chains linked to each other caused strong interaction between the molecules, thus prevent the liquid from easily flow [16]. This shows that the seed gum solution viscosity has high gel strength and suitable for candy making. It able to hydrate rapidly in cold water systems and forms a viscous colloidal dispersion when completely hydrated.
3.2 Hardness of Candy Sample
Hardness properties of composite gelling agent was as in Table 2. All samples except SG50F50 and SG75FG25 shows significance difference (P<0.05) to each other. The composite SG25FG75 showed highest hardness values, followed by SG50FG50, commercial, SG75FG25, FG100 and SG100 which is 4.72 ± 0.01, 4.71 ± 0.01, 2.73 ± 0.05, 2.28 ± 0.08, 1.30 ± 0.12 and 0.59 ± 0.05 respectively. It was observed that small durian seed gum (SG) amount in formulation could improve the hardness of gummy candy. Improved in hardness properties among composite gelling agent was due to protein-polysaccharide interaction between cationic domain of fish gelatin and anionic domain of durian seed gum, thus resulting in stronger synergistic network [17];[18].

Table 2. Hardness of samples

| Sample  | Hardness (g) | Newton unit |
|---------|--------------|-------------|
| SG100   | 60.00 ± 4.72c | 0.59 ± 0.05c |
| SG75FG25| 232.21 ± 8.53b | 2.28 ± 0.08b |
| SG50FG50| 480.54 ± 0.67a | 4.71 ± 0.01a |
| SG25FG75| 481.31 ± 0.92a | 4.72 ± 0.01a |
| FG100   | 132.14 ± 11.82d | 1.30 ± 0.12d |
| Commercial | 278.58 ± 4.78b | 2.73 ± 0.05b |

3.2. Colour of Candy Sample
Colour properties of produced gummy candy were presented in Table 3. In terms of lightness (L*), all samples shows significance difference (P<0.05) with commercial samples. FG100 shows the highest lightness, followed by SG25FG75, SG50FG50, SG75FG25 and SG100. This shows that the lightness of gummy candy increase as the durian seed gum concentration decreases. All samples was also lighter in respect to commercial sample.

The gummy candy produced using high seed gum is significantly difference (p<0.05) with the one with low concentration of seed gum. The sample SG75FG25 has the highest value in red/green coordinate (a*) at (Δ5.03 ± 0.05), however is significantly less red than the commercial sample (21.18 ± 1.45). It is observed that with the increase of durian seed gum concentration would produce redder candy. In contrast, the control gummy candy from fish gelatine (FG100) has lowest red/green coordinate (a*) at (Δ1.02 ± 0.05).

Meanwhile, for yellow/blue coordinate (b*), there is also a significance difference (p<0.05) between samples of low seed gum concentration and high seed gum concentration. The gummy candy from composite SG25FG75 has the highest and higher yellowness colour (Δ12.44 ± 0.05) than SG 100 and SG75FG25 with the value of 8.45 ± 0.7 and 9.71 ± 0.19 respectively. It was observed that low seed gum concentration increases the yellowness in the colour of the gummy candy produced.

Table 3. Colour profiles samples

| Sample  | L*        | a*        | b*        |
|---------|-----------|-----------|-----------|
| SG100   | 30.63 ± 0.92c | 4.85 ± 1.00b | 8.45 ± 0.70b |
| SG75FG25| 37.79 ± 0.69b | 5.04 ± 0.22b | 9.71 ± 0.19b |
| SG50FG50| 50.84 ± 0.43a | 4.31 ± 0.28bc | 11.97 ± 0.49a |
| SG25FG75| 51.22 ± 0.34a | 2.52 ± 0.07cd | 12.44 ± 0.30a |
| FG100   | 51.86 ± 1.41a | 1.02 ± 0.16d | 11.64 ± 0.44a |
| Commercial | 28.44 ± 0.22d | 21.18 ± 1.45a | 9.19 ± 0.96b |
3.3 Preference test of Candy Sample

Table 4 shows sensory test results for all samples. Sample SG75FG25 (69 total scores) shows the most preferred taste, aroma, hardness, gumminess and potential to buy which is 12, 10, 16, 14 and 17 scores respectively. This shows that the most suitable formulation for the Durio zibethinus seed gum candy is SG75FG25.

| Candy Rating/Sample | SG100 | SG75FG25 | SG50FG50 | SG25FG75 | FG100 |
|---------------------|-------|----------|----------|----------|-------|
| Taste               | 4     | 12       | 9        | 3        | 2     |
| Aroma               | 3     | 10       | 6        | 2        | 9     |
| Hardness            | 2     | 16       | 7        | 3        | 2     |
| Gumminess           | 3     | 14       | 8        | 5        | 0     |
| Potential to buy    | 0     | 17       | 11       | 1        | 1     |
| Total               | 12    | 69       | 41       | 14       | 14    |

4. Conclusions

As the research has demonstrated, durian seed gums are a good gelling agent that can replace gelatin in the making of gummy confection. Overall, the gummy candy with the formulation of 75% durian seed gum and 25% gelatin has the closest similarity with the commercial gummy confection. The amount of gelatin in the commercial gummy confection is higher than the gummy confection produced from this research. For future study, the usage of the other parts of the durian seeds can be studied and be applied to the daily used products. There might be other undiscovered usage of the sediments and more research can be done on this.

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