The formulation of mangosteen peel extract microencapsulation on water content and fungus distribution during storage

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Abstract. The purpose of this study was to examine the effect of formulation on microencapsulation of mangosteen peel extract (MPE) on water content and fungus distribution. The treatments tested consisted of: M1 (70% MPE: 30% maltodextrin/MDX), M2 (60% MPE: 40% MDX), M3 (50% MPE: 50% MDX), M4 (40% MPE: 60% MDX), M5 (30% MPE: 70% MDX), and M6 (100% MPE). Each treatment was observed for 0, 2, 4, 6, and 8 weeks. The results showed that the microencapsulation treatment of mangosteen peel extract with maltodextrin (M1 – M5) had a significant effect (P<0.05) on water content and fungus distribution. The water content of the sample starts to increase in the second week and increases with increasing shelf life. The fungal distribution parameters showed the formation of colonies and product damage in the fourth week and continued to increase until the eighth week. This study shows that the microencapsulation treatment (M1 – M5) is able to protect the material from environmental influences and can extend the shelf life of the material rather than the control treatment (M6). The M4 treatment containing 40% mangosteen peel extract and 60% maltodextrin showed the best results on the water content and fungus distribution.

Keywords: mangosteen peel, fungus, microencapsulation, storage duration, water content.

1. Introduction

Mangosteen peel extract contains xanthones which is reported to have strong antioxidant activity [1]. Storage duration has been reported to interfere with the stability of medicinal products such as mangosteen peel extract [2]. One way that can be applied to maintain the stability of mangosteen peel extract is the microencapsulation method. Hidayah [3] reports that microencapsulation aims to protect core materials from environmental influences such as oxidation, oxygen and aroma so that it remains stable. Microencapsulation can control the release of the coating material in the core material, maintain the stability of the core material and prevent the loss of nutrients [4] and increase the solubility of food products [5]. Maltodextrin is widely used in the microencapsulation process because it is easily soluble in water, has a low viscosity level and is colorless [6]. Batista et al. [7] reported that maltodextrin was very effective as a protective material encapsulated from oxidation processes. Yuliawaty et al. [8] added that maltodextrin has high solubility in water because it contains hydroxyl groups that can interact with
water, have groups that are loaded with many amino acids, so they dissolve easily in polar solvents. Maltodextrin is reported to have a small molecular weight with a simple structure and can interact with water well [9].

Microencapsulated products have been reported to be stable for up to 8 weeks [10]. Mangosteen peel extract which has been carried out by microencapsulation process using a maltodextrin coating material is expected to maintain product stability during storage. The aim of this study was to determine the effect of storage duration on moisture content and fungus distribution on mangosteen peel extract microcapsules.

2. Materials and method

Mangosteen peel extract and maltodextrin are made in microparticle size and then formulated in various balances of mangosteen peel extract with maltodextrin (30:70, 40:60, 50:50, 60:40, 70:30). Each formulation was then homogenized for 15 minutes with a homogenizer, then hydrated for 18 hours at 40°C. After that it was homogenized again for 1 minute then sprayed dried using a spray dryer at a feed rate of 15 mL min⁻¹ with an inlet temperature of 170°C and a pressure of 1 atm [11].

Microencapsulation of mangosteen peel extract products that have been formulated according to the treatment level have been tested for durability against storage duration for 0, 2, 4, 6, and 8 weeks. Storage is carried out at room temperature (22-26°C) where each sample is put into plastic as much as 250 g / unit from each treatment. Then the water content and fungus distribution were tested in each treatment.

3. Results and discussion

The results of testing the water content of the mangosteen peel extract formulation with maltodextrin are presented in Table 1 and Figure 1. The results showed the water content in the M1-M6 treatment relatively increased with increasing storage duration. These results are in line with Mukhlis [12] research that the longer storage duration tends to increase the moisture content of the material so that it can cause the growth of fungi. Christensen and Kaufmann [13] added that the longer storage can increase the water content of materials that can support the growth of microorganisms so that the feed material is damaged. M6 treatment at all storage durations showed significant differences with treatments M1, M2, M3, M4 and M5. This condition shows that the water content of M6 that does not undergo microencapsulation process has an influence on the increase in water content. The M1 - M5 treatment that underwent a microencapsulation process resulted in a lower water content than M6.

Table 1. Effect of long storage of mangosteen peel extract microcapsule products on water content

| Treatment       | Water Content (%) |
|-----------------|-------------------|
|                 | 0  | 2  | 4  | 6  | 8   |
| M1 (70% MPE : 30% MDX) | 6.87±0.33³ | 7.74±0.17² | 8.41±0.32³ | 9.50±0.06⁷ | 10.13±0.35³ |
| M2 (60% MPE : 40% MDX)   | 6.99±0.27³ | 7.69±0.11² | 8.72±0.13³ | 9.95±0.16² | 10.09±0.23³ |
| M3 (50% MPE : 50% MDX)   | 6.82±0.33³ | 7.58±0.36² | 9.01±0.69³ | 9.95±0.39³ | 10.39±0.19³ |
| M4 (40% MPE : 60% MDX)   | 7.15±0.32³ | 7.80±0.13² | 9.07±0.10³ | 10.44±0.29³ | 10.92±0.41³ |
| M5 (30% MPE : 70% MDX)   | 7.11±0.45³ | 7.91±0.14² | 8.92±0.36³ | 10.09±0.39³ | 10.73±0.41³ |
| M6 (100% MPE)            | 7.04±0.53³ | 8.02±0.38² | 9.87±0.28³ | 11.52±0.95³ | 12.70±0.14³ |

Note: Different superscripts in the same column show significant differences (P <0.05)

All treatments (M1 - M6) at 0 weeks storage duration were not significantly different. Meanwhile, in the 2nd to 8th week storage there was a significant difference. Water content in the
second week, M3 treatment was significantly different from M6. The M1 treatment showed significant differences with M3, M4 and M6 in the fourth week. Furthermore, at the sixth week, the M1 treatment was significantly different from M6 and at the eighth week, the M1 and M2 treatments were significantly different from M6. This condition shows that the M1 treatment containing 70% EKM and 30% MDX has the most stable water content during storage compared to M6. This is due to the process of microencapsulation with the addition of maltodextrin which is able to form a waterproof membrane surface with high resistance to diffusion of water vapor by forming complex formations making it difficult for water vapor diffusion from the environment to enter into microcapsule product molecules [14].

![Figure 1. Water content of microcapsule products](image)

**Table 2.** Effect of storage duration of mangosteen peel extract microcapsules on fungus distribution (log cfu / g)

| Treatment                  | Fungus Distribution (log cfu / g) |
|----------------------------|-----------------------------------|
| M1 (70% MPE : 30% MDX)    | 0,00±0,00<sup>a</sup> 0,10±0,03<sup>a</sup> 0,14±0,02<sup>a</sup> 0,25±0,07<sup>a</sup> 0,29±0,04<sup>a</sup> |
| M2 (60% MPE : 40% MDX)    | 0,00±0,00<sup>a</sup> 0,10±0,04<sup>a</sup> 0,15±0,07<sup>a</sup> 0,28±0,09<sup>a</sup> 0,32±0,09<sup>a</sup> |
| M3 (50% MPE : 50% MDX)    | 0,00±0,00<sup>a</sup> 0,12±0,04<sup>ab</sup> 0,21±0,02<sup>a</sup> 0,43±0,08<sup>b</sup> 0,46±0,16<sup>b</sup> |
| M4 (40% MPE : 60% MDX)    | 0,00±0,00<sup>a</sup> 0,12±0,03<sup>ab</sup> 0,17±0,05<sup>a</sup> 0,44±0,06<sup>b</sup> 0,50±0,05<sup>b</sup> |
| M5 (30% MPE : 70% MDX)    | 0,00±0,00<sup>a</sup> 0,14±0,02<sup>ab</sup> 0,23±0,08<sup>a</sup> 0,42±0,08<sup>b</sup> 0,49±0,12<sup>b</sup> |
| M6 (100% MPE)             | 0,00±0,00<sup>a</sup> 0,16±0,04<sup>b</sup> 0,23±0,05<sup>a</sup> 0,43±0,10<sup>b</sup> 0,54±0,06<sup>b</sup> |

Note: Different superscripts in the same column show significant differences (P <0.05)

Microbial distribution testing is important to test as an indicator of material resistance from microbial contamination. The results of the study on the effect of storage duration of mangosteen peel extract microcapsules on the distribution of fungus are presented in Table 2 and Figure 2. The results of the distribution test of fungus on mangosteen peel extract formulation and maltodextrin as presented in Table 2 show that the storage duration of 2, 6 and 8 weeks affects the distribution of fungus. At 2 weeks storage, treatment of M1 and M2 produced a number of fungus distribution that was significantly different from M6. While the storage period for 6 and 8 weeks showed that
the treatment of M1 and M2 were significantly different from M3, M4, M5 and M6. This condition shows that M1 and M2 treatments produce a better spread of fungi. M6 treatment containing 100% mangosteen peel extract without encapsulation with maltodextrin has the highest fungal distribution value compared to the microcapsule treatment. This condition is positively correlated with the water content in Table 1 where the higher water content causes faster mold growth. The M6 treatment contains much higher water content than the M1 and M2 treatments so that it can stimulate mold growth more quickly. The microencapsulation process showed a slower growth of the fungal population in the M1 and M2 treatments compared to the M6 treatment because M1 and M2 contained maltodextrin which could prevent water absorption in the microcapsule product. Low water content in microcapsule products causes the chance of microbial growth getting smaller [15].

Mangosteen peel and maltodextrin extract formulations at optimal levels (M1 and M2) contain nutrients such as sugar as a source of energy for fungus growth that is less than M3, M4 and M5. The higher nutrient content can affect faster fungus growth in M3, M4 and M5. This is caused by the presence of influencing factors such as nutrition, water activity, temperature, consistency, hydrogen ion concentration and nutrient status [16,12]. The longer storage duration (weeks 6 and 8) results in the highest distribution of fungi (> 2.5 log cfu / g) compared to other storage durations (0, 2 and 4 weeks). The higher fungus distribution value at weeks 6 and 8 is influenced by the water content of the product at the time of storage also increases. This situation will cause an opportunity for microorganisms, especially fungi will grow. The distribution value of fungus in the 8th week contained the highest water content up to >10% compared to the 0th week until the 6th week. This is caused by the level of particle density at the 8th week is more loose so it is able to absorb water higher. Other studies report that wafer feed products can absorb more free air vapor in longer storage [17]. Increased water content in the 8th week can cause unstable texture of the material and is suitable as a medium for microbial growth [18]. This is because water is one of the growth media that is suitable for microbes including fungi.

Figure 2. Fungus distribution of microcapsule products
4. Conclusion
The storage duration has a significant effect on water content and the fungus distribution of mangosteen peel extract microcapsules. Water content and fungus distribution increase with increasing storage duration.

5. References
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