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Combination of Maltodextrin and Gum Arabic as wall materials in Proficiency of Microencapsulated Durian (*Durio zibethinus*) Powder during Spray Drying

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Durian (*Duriozibethinus*) is a high valued tropical fruit crop. However it has a short postharvest shelf life at ambient preservation. Converting this valuable fruit into dehydrated forms by spray drying method has been highly evaluated to produce long stability, light weight dry powders and agglomerates. This research examined the possibility of maltodextrin and gum arabic as wall materials in microencapsulation of durian powder during spray drying. Maltodextrin was formulated with gum arabic in different ratios (20:80, 30:70, 40:60, 50:50, 60:40, 70:30, 80:20). Encapsulation proficiency (%), bulk density (g/cm^3) were evaluated. Oxidative stability of durian powder was also monitored during 6 months of storage by measuring peroxide value (meq peroxide/kg powder). The encapsulation proficiency values ranged from 54.17% to 83.11%, being the highest value obtained for maltodextrin: gum arabic (50:50). Solubility % of durian powder samples were significantly increased with increasing ratio of maltodextrin: gum arabic from 20:80 to 60:40. Hygroscopicity percentage of all durian powder samples significantly increased with increasing the maltodextrin: gum arabic ratio from from 20:80 to 70:30. Bulk density values ranged from 0.27 to 0.52 g/cm^3 with the highest value recorded at maltodextrin: gum arabic (50:50). Oxidative stability was strongly influenced by the wall material combination. Maltodextrin: gum arabic (60:40) showed the best protection against oxidation. Combination of maltodextrin and gum arabic had a great influence on physicochemical qualities of spray dried durian powder. A successful microencapsulation resulted in a spray dried powder with minimum oxidative reaction and maximum retention of phytochemical components.

Keywords: Bulk density, durian powder, encapsulation proficiency, gum arabic, hygroscopicity, maltodextrin, oxidative stability, solubility

INTRODUCTION

Durian (*Duriozibethinus*) is thorny, perishable, rich in nutrient and specific odor (Panditharathana et al. 2018). It is seasonal with a short postharvest shelf life at ambient storage (Ho and Rajeev, 2015). The odor and bulky thorny husk of this fruit created limited utilization in shipping, distribution and commerce (Small and Catling, 2011). Spray drying method could resolve this problem by processing raw fruits into dehydrated forms with long stability, light weight dry powders and

agglomerates (Sagarand Kumar, 2010; Yousefi et al. 2011). It could dehydrated suspension rapidly for time saving and minimal processing (Chegini and Ghobadian, 2007; Quek, 2007; Murugesan and Orsat, 2011; Phisut, 2012). In spray drying, the major optimized parameters were inlet/ outlet air temperature, relative humidity of air and atomizer speed. Wall materials were also important to increase the glass transition temperature (Anjali and Satya, 2015). The glass transition temperature was important to estimate

the collapse of the powder and the permeation of the powder matrix to flavor compounds (Apinan et al. 2015). Maltodextrin was a hydrolyzed starch widely utilized as wall material in microencapsulation of food ingredients (Gharsallaoui et al. 2007). It provided benefits such as relatively low cost, neutral aroma and taste, low viscosity and excellent prevention from oxidative rancidity. However, it had low emulsifying property. Gum arabic had high solubility, low viscosity and good emulsifying characteristics (Charve and Reineccius, 2009). Hence, a combination of maltodextrin with gum arabic was desirable to achieve an effective microencapsulation through spray drying (Fernandes et al. 2008, Bule et al. 2010).

Objective of our study evaluated the potential of maltodextrin in combination with gum arabic as wall materials for microencapsulation of durian powder during spray drying. The dry powder was characterized for encapsulation proficiency, solubility percentage, hygroscopicity percentage, bulk density. This spray dried durian powder also observed oxidative stability during 6 months of storage.

MATERIALS AND METHODS

Material

Ripen durian fruits were harvested from KeSach district, SocTrang province, Vietnam. The fresh pulp was obtained by removing hull and seeds. Pulp was blended with flake ice at ratio 1:2.5. Pulp was filtered using a stainless steel strainer and mixed with wall materials properly. Maltodextrin, gum arabic and other chemical reagents were all analytical grade.

Researching method

Maltodextrin (MD) and gum arabic (GA) powder in different ratios (20:80, 30:70, 40:60, 50:50, 60:40, 70:30, 80:20) were completely dissolved in distilled water. These mixtures were added into durian juice at concentration 25% to form emulsion. Spray drying process was conducted in a laboratory scale spray dryer at inlet and outlet air temperature (170 ± 0.5 °C and 90 ± 0.5 °C, respectively) and feed flow rate (15 ± 0.5 ml/min), air pressure 0.05 MPa, drying air flow rate 65 m³/h to get the final moisture content of dried powder $1.60 \pm 0.15\%$.

Physicochemical determination

The final spray dried durian powder was carefully examined encapsulation proficiency,

solubility percentage, hygroscopicity percentage, bulk density, and oxidative stability. Encapsulation proficiency (%) was estimated according to the procedure described by Bae and Lee (2008). Solubility percentage was calculated by using the Eastman & Moore method described by Goula and Adamopoulos (2010). Hygroscopicity percentage was examined by method described by Goula and Adamopoulos (2010). Bulk density (g/cm³) was evaluated by method described by Goula and Adamopoulos (2004). The peroxide value (meq peroxide/kg powder) was determined by spectrophotometry described by Helena et al. (2013) and Gharsallaoui et al. (2007).

Statistical analysis

The experiments were run in triplicate with different groups of samples. The data were presented as mean \pm standard deviation. Statistical analysis was performed by the Statgraphics Centurion version XVI.

RESULTS AND DISCUSSION

Encapsulation proficiency

The encapsulation proficiency in durian powder by different ratios of maltodextrin: gum arabic was clearly presented in table 1. The encapsulation proficiency values ranged from 54.17% to 83.11%, being the highest value obtained for maltodextrin: gum arabic (50:50). The encapsulation proficiency gradually decreased during storage. According to Barbosa et al. (2005), the more stable the emulsion, the higher the encapsulation proficiency was, i.e., the lower the amount of nonencapsulated material on particles surface. Charve and Reineccius (2009) proved that modified starch showed the highest oil retention. Helena et al. (2013) confirmed that a mixture of maltodextrin and modified starch gave the best encapsulation efficiency.

Solubility percentage

Solubility % of all treatments were significantly increased with increasing ratio of maltodextrin: gum arabic from 20:80 to 60:40. Afterwards (70:30 and 80:20, maltodextrin: gum arabic), the solubility percentage of durian powder was gradually decreased (table 2). Solubility of all formulas were slightly decreased during storage. Similarly, results were obtained for sweet potato powder with increasing maltodextrin (Grabowski et al. 2006).

Table 1: Encapsulation proficiency (%) in durian powder by different ratios of maltodextrin: gum arabic

MD:GA	20:80	30:70	40:60	50:50	60:40	70:30	80:20
1 st month	54.17±0.53 ^d	59.83±0.41 ^{cd}	64.27±0.25 ^c	69.85±0.37 ^{bc}	83.11±0.16 ^a	77.63±0.22 ^{ab}	73.04±0.09 ^b
2 nd month	53.44±0.18 ^d	59.26±0.21 ^{cd}	63.91±0.30 ^c	69.42±0.24 ^{bc}	82.79±0.15 ^a	77.25±0.16 ^{ab}	72.66±0.42 ^b
3 rd month	53.01±0.19 ^d	58.89±0.34 ^{cd}	63.58±0.23 ^c	69.06±0.17 ^{bc}	82.31±0.11 ^a	76.97±0.38 ^{ab}	72.24±0.15 ^b
4 th month	52.63±0.15 ^d	58.33±0.36 ^{cd}	63.07±0.14 ^c	68.70±0.25 ^{bc}	82.05±0.39 ^a	76.60±0.12 ^{ab}	71.95±0.11 ^b
5 th month	52.14±0.07 ^d	58.02±0.22 ^{cd}	62.74±0.16 ^c	68.24±0.13 ^{bc}	81.74±0.27 ^a	76.39±0.30 ^{ab}	71.57±0.13 ^b
6 th month	51.75±0.14 ^d	57.73±0.11 ^{cd}	62.11±0.17 ^c	67.93±0.40 ^{bc}	81.20±0.31 ^a	76.05±0.23 ^{ab}	71.13±0.17 ^b

Note: the values were expressed as the mean of twenty two samples; the same characters (denoted above), the difference between them was not significant ($\alpha = 5\%$).

Table2: Solubility (%) in durian powder by different ratios of maltodextrin: gumArabic

MD:GA	20:80	30:70	40:60	50:50	60:40	70:30	80:20
1 st month	67.42±0.15 ^d	69.54±0.18 ^{cd}	73.19±0.20 ^c	76.80±0.24 ^{bc}	84.39±0.09 ^a	82.01±0.20 ^{ab}	79.43±0.17 ^b
2 nd month	67.21±0.24 ^d	69.30±0.11 ^{cd}	72.96±0.17 ^c	76.56±0.30 ^{bc}	83.14±0.14 ^a	81.74±0.14 ^{ab}	79.11±0.25 ^b
3 rd month	69.97±0.12 ^d	69.09±0.25 ^{cd}	72.73±0.13 ^c	76.32±0.15 ^{bc}	82.85±0.27 ^a	81.57±0.15 ^{ab}	78.85±0.14 ^b
4 th month	69.71±0.36 ^d	68.78±0.31 ^{cd}	72.54±0.22 ^c	76.17±0.17 ^{bc}	82.62±0.19 ^a	81.30±0.33 ^{ab}	78.62±0.30 ^b
5 th month	69.52±0.29 ^d	68.53±0.17 ^{cd}	72.30±0.19 ^c	75.93±0.28 ^{bc}	82.35±0.03 ^a	81.04±0.19 ^{ab}	78.47±0.16 ^b
6 th month	69.24±0.33 ^d	68.27±0.33 ^{cd}	72.05±0.11 ^c	75.69±0.14 ^{bc}	82.10±0.16 ^a	80.82±0.26 ^{ab}	78.23±0.22 ^b

Note: the values were expressed as the mean of twenty two samples; the same characters (denoted above), the difference between them was not significant ($\alpha = 5\%$).

Table 3: Hygroscopicity (%) in durian powder by different ratios of maltodextrin: gum Arabic

MD:GA	20:80	30:70	40:60	50:50	60:40	70:30	80:20
1 st month	73.96±0.16 ^d	82.55±0.10 ^c	87.59±0.26 ^{bc}	90.43±0.13 ^b	93.44±0.17 ^{ab}	95.80±0.11 ^a	96.01±0.13 ^a
2 nd month	73.31±0.13 ^d	82.01±0.19 ^c	87.00±0.12 ^c	89.78±0.26 ^b	92.79±0.14 ^{ab}	95.54±0.20 ^a	95.60±0.12 ^a
3 rd month	72.74±0.24 ^d	81.35±0.22 ^c	86.38±0.15 ^c	89.15±0.12 ^b	92.14±0.22 ^{ab}	94.93±0.17 ^a	94.91±0.11 ^a
4 th month	72.09±0.30 ^d	80.70±0.17 ^c	85.73±0.19 ^c	88.46±0.18 ^b	91.50±0.16 ^{ab}	94.27±0.22 ^a	94.30±0.09 ^a
5 th month	71.40±0.16 ^d	80.16±0.13 ^c	85.14±0.31 ^c	87.83±0.19 ^b	90.87±0.14 ^{ab}	93.65±0.13 ^a	93.69±0.13 ^a
6 th month	69.83±0.20 ^d	79.57±0.18 ^c	84.52±0.24 ^c	87.21±0.08 ^b	90.22±0.12 ^{ab}	93.07±0.15 ^a	93.04±0.15 ^a

Note: the values were expressed as the mean of twenty two samples; the same characters (denoted above), the difference between them was not significant ($\alpha = 5\%$).

Table4: Bulk density (g/cm³) in durian powder by different ratios of maltodextrin: gum Arabic

MD:GA	20:80	30:70	40:60	50:50	60:40	70:30	80:20
1 st month	0.27±0.01 ^d	0.34±0.02 ^{cd}	0.39±0.00 ^c	0.52±0.03 ^a	0.47±0.01 ^{ab}	0.43±0.02 ^b	0.41±0.00 ^{bc}
2 nd month	0.26±0.00 ^d	0.33±0.03 ^{cd}	0.37±0.01 ^c	0.51±0.02 ^a	0.46±0.01 ^{ab}	0.42±0.01 ^b	0.40±0.00 ^{bc}
3 rd month	0.25±0.02 ^d	0.30±0.00 ^{cd}	0.34±0.03 ^c	0.50±0.01 ^a	0.43±0.00 ^{ab}	0.39±0.02 ^b	0.37±0.01 ^{bc}
4 th month	0.23±0.01 ^d	0.28±0.02 ^{cd}	0.30±0.00 ^c	0.48±0.03 ^a	0.41±0.01 ^{ab}	0.35±0.00 ^b	0.33±0.03 ^{bc}
5 th month	0.20±0.00 ^d	0.25±0.01 ^{cd}	0.27±0.02 ^c	0.45±0.01 ^a	0.38±0.00 ^{ab}	0.32±0.01 ^b	0.30±0.00 ^{bc}
6 th month	0.19±0.01 ^d	0.21±0.02 ^{cd}	0.24±0.03 ^c	0.41±0.00 ^a	0.36±0.02 ^{ab}	0.29±0.00 ^b	0.26±0.01 ^{bc}

Note: the values were expressed as the mean of twenty two samples; the same characters (denoted above), the difference between them was not significant ($\alpha = 5\%$).

Table 5: Peroxide value (meq peroxide/kg powder) in durian powder by different ratios of maltodextrin: gum Arabic

MD:GA	20:80	30:70	40:60	50:50	60:40	70:30	80:20
1 st month	4.15±0.02 ^a	3.86±0.01 ^{ab}	3.14±0.03 ^{bc}	2.84±0.02 ^{cd}	2.67±0.00 ^d	2.96±0.03 ^c	3.59±0.01 ^b
2 ⁿ month	4.21±0.03 ^a	3.91±0.00 ^{ab}	3.17±0.02 ^{bc}	2.90±0.01 ^{cd}	2.68±0.03 ^d	2.98±0.00 ^c	3.62±0.01 ^b
3 rd month	4.28±0.01 ^a	3.96±0.02 ^{ab}	3.22±0.01 ^{bc}	2.96±0.02 ^{cd}	2.73±0.01 ^d	3.04±0.01 ^c	3.67±0.03 ^b
4 th month	4.35±0.00 ^a	4.01±0.01 ^{ab}	3.26±0.03 ^{bc}	3.03±0.00 ^{cd}	2.78±0.02 ^d	3.09±0.03 ^c	3.72±0.00 ^b
5 th month	4.42±0.01 ^a	4.09±0.03 ^{ab}	3.31±0.00 ^{bc}	3.09±0.02 ^{cd}	2.84±0.03 ^d	3.14±0.00 ^c	3.77±0.02 ^b
6 th month	4.50±0.02 ^a	4.15±0.00 ^{ab}	3.39±0.02 ^{bc}	3.14±0.01 ^{cd}	2.89±0.00 ^d	3.18±0.02 ^c	3.81±0.00 ^b

Note: the values were expressed as the mean of twenty two samples; the same characters (denoted above), the difference between them was not significant ($\alpha = 5\%$).

Panditharathana et al. (2018) confirmed that solubility (%) of spray dried durian powder increased with increasing of maltodextrin percentage.

Hygroscopicity percentage

Hygroscopicity percentage of all treatments significantly increased with increasing the maltodextrin: gum arabic ratio from 20:80 to 70:30. There was not significant difference of hygroscopicity percentage in durian powder at 70:30 and 80: 20 (table 3). Panditharathana et al. (2018) demonstrated that hygroscopicity (%) of spray dried durian powder increased with increasing of maltodextrin percentage. The hygroscopicity percentage was increased with increasing maltodextrin % due to decreasing the moisture content (Cai and Corke, 2000; Tonon, 2008). Goula and Adamopoulos (2012) indicated that the hygroscopicity decreased with an increase in maltodextrin concentration. Without the additional wall materials, the lower hygroscopicity of the low salt fish sauce powder with the low product recovery was reported (Chindapan et al. 2010)

Bulk density

Bulk density variations of durian powder encapsulated with different ratios of maltodextrin: gum arabic were presented in table 4. Bulk density values ranged from 0.27 to 0.52 g/cm³ with the highest value recorded at maltodextrin: gum arabic (50:50). The benefit of dried powder with higher density was that it could be kept in large amount into smaller bag when compared to product with lower density. Apart from that, higher bulk density implied lower amount of air occluded in the spaces between particles, which can help to avoid oxidative rancidity (Helena et al. 2013).

Oxidative stability

Peroxide value variations of durian powder encapsulated with different ratios of maltodextrin: gum arabic were presented in table 5. At beginning of preservation, all samples showed a low level of oxidation, ranging from 2.67 to 4.15 meq peroxide/kg powder. Durian powder microencapsulated by maltodextrin: gum arabic (60:40) showed the lowest peroxide value accumulation after 6 months of storage. Peroxide values of powder microencapsulated at 50:50 and 60:40 (maltodextrin: gum arabic) were not significant difference during preservation. Jimenez et al. (2006) found that whey protein concentrate

was more suitable in the prevention from lipid oxidation than gum arabic. Sung-Tong et al. (2010) affirmed that the kinds of drying wall materials incorporated significantly affected volatiles retention in the spray-dried durian powder. The incorporation of gum arabic caused higher retention of volatiles in the durian powder as compared to maltodextrin. The rates of volatiles emission from the spray-dried powder under accelerated storage condition increased remarkably at higher relative humidity. Helena et al. (2013) concluded that a combination of maltodextrin and whey protein concentrate was the wall material that best protected the active material against lipid oxidation. Panditharathana et al. (2018) recommended maltodextrin for the spray drying to obtain best quality durian powder.

CONCLUSION

Spray drying converted durian pulp into dried powders with good quality, low moisture content, easy distribution and storage. Moreover it also protected the active components against undesirable reactions. This research demonstrated that durian pulp could be converted into powder by spray drying with the supporting of maltodextrin and gum arabic as wall materials. Increasing maltodextrin: gum arabic ratio to 50:50 or 60:40 obtained the best encapsulation proficiency, solubility percentage, hygroscopicity percentage, bulk density, and oxidative stability. Therefore, maltodextrin and gum arabic have a great impact on various physicochemical attributes of spray dried durian powder.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

Nguyen Phuoc Minh arranged the experiments and also wrote the manuscript.

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REFERENCES

- Anjali V. and V. S. Satya (2015). Spray drying of fruit and vegetable juices—a review. *Critical Reviews in Food Science and Nutrition* 55 : 701-719.
- Apinan S., P. Riitta, L. N. Tze, Y. Hidefumi (2015). Encapsulation of hydrophilic and hydrophobic flavors by spray drying. *Japan Journal of Food Engineering* 16 : 37-52.
- Bae E. K., S. J. Lee (2008). Microencapsulation of avocado oil by spray drying using whey protein and maltodextrin. *Journal of Microencapsulation* 25 : 549-560.
- Barbosa M. I. M. J., C.D. Borsarelli, A. Z. Mercadante (2005). Light stability of spray-dried bixin encapsulated with different edible polysaccharide preparations. *Food Research International* 38 : 989-994.
- Chegini R. G. and B. Ghobadian (2007). Spray dryer parameters for fruit juice drying. *World Journal of Agricultural Science* 3 : 230-236.
- Cai Y. Z. and H. Corke (2000). Production and properties of spray dried *Amaranthus* betacyanin pigments. *Journal of Food Science* 65 : 1248-1252.
- Charve J., G. A. Reineccius (2009). Encapsulation performance of proteins and traditional materials for spray dried flavors. *Journal of Agricultural and Food Chemistry* 57 : 2486-2492.
- Chindapan N., S. Devahastin, N. Chiewchan (2010). Effect of electrodialysis pretreatment on physicochemical properties and morphology of spray-dried-fish sauce powder. *J. Food Eng.* 99 : 31-39.
- Goula A. M., K.G. Adamopoulos (2004). Spray drying of tomato pulp: effect of feed concentration. *Drying Technology* 22 : 2309-2330.
- Goula M. A. and K. G. Adamopoulos (2010). A new technique for spray drying orange juice concentrate. *Innovative Food Science and Emerging Technologies* 11 : 324-351.
- Goula A. M. and K. G. Adamopoulos (2012). A new technique for spray-dried encapsulation of lycopene. *Drying Technol.* 30 : 641-652.
- Grabowski J. A., V. D. Truong, D. R. Daubert (2006). Spray drying of amylase hydrolyzed sweet potato puree and physicochemical properties of powder. *Journal of Food Science* 71 : 209–217.
- Helena C. F. C., V. T. Renata, R. F. G. Carlos, D. H. Míriam (2013). Encapsulation efficiency and oxidative stability of flaxseed oil microencapsulated by spray drying using different combinations of wall materials. *Journal of Food Engineering* 115 : 443-451.
- Ho L. H. and B. Rajeev (2015). Exploring the potential nutraceutical values of (*Duriozibethinus* L.) An exotic tropical fruit. *Food Chemistry* 168 : 80–99
- Jimenez M., H.S. García, C.I. Beristain (2006). Spray dried encapsulation of conjugated linoleic acid (CLA) with polymeric matrices. *Journal of the Science of Food and Agriculture* 86: 2431-2437.
- Murugesan R. and V. Orsat (2011). Spray drying for the production of nutraceutical ingredients-a review. *Food Bioprocess Technology* 8 : 1-12.
- Panditharathana P. W. M. H. P., H. R. P. Fernando, P. K. Dissanayake (2018). Production of durian (*Duriozibethinus*) powder by spray drying technique. *Tropical Agriculturist* 166 : 153-168.
- Phisut N. (2012). Spray drying technique of fruit juice powder: some factors influencing the properties of product. *International Food Research Journal* 19 : 1297-1306.
- Quek Y. S., N.K. Chok, P. Swedlund (2007). The physicochemical properties of spray-dried watermelon powders. *Chemical Engineering and Processing* 46 : 386-392.
- Sagar V. R. and P. S. Kumar (2010). Recent advances in drying and dehydration of fruits and vegetables: a review. *Journal of Food Science and Technology* 47: 15-26.
- Small E. and P. M. Catling (2011). Blossoming treasures of biodiversity a smell from hell but a taste from heaven. *Journal of the Biodiversity* 6 : 33-38.
- Sung-Tong C., A. H. N. Sheikh, Q. Siew-Young, B. C. M. Yaakob, A. R. Russly, M. H. Dzulkifly (2010). Effect of thermal processing and storage condition on the flavour stability of spray-dried durian powder. *LWT - Food Science and Technology* 43 : 856-861.
- Tonon V. R., C. Brabet, M. Hubinger (2008). Influence of process conditions on the physicochemical properties of acai powder produced by spray drying. *Journal of Food Engineering* 88 : 411-418.

Yousefi S., Z. Emam-Djomeh, M. S. Mousavi (2011). Effect of carrier type and spray drying on the physicochemical properties of powdered and reconstituted pomegranate juice (*PunicaGranatum* L.). Journal of Food Science and Technology 48 : 677-684.