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The Potential of Dietary Fiber and Antioxidants From Muntingia Calabura L. Fruit Flour in Low-Calorie Biscuits and Their Acceptability for The Prevention of Overweight and Obesity

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ABSTRACT

Background: *Overweight and obesity are growing global public health concerns, closely linked to oxidative stress and low dietary intake of fiber and antioxidants. Kersen fruit (Muntingia calabura L.) shows potential as a functional food ingredient due to its high dietary fiber and natural antioxidant content. This study aimed to evaluate the potential of kersen fruit flour in developing low-calorie biscuits as a preventive strategy against overweight and obesity, and to assess product acceptability.*

Research Methods: *The study employed an experimental design. Kersen fruit flour was produced through steam blanching, vacuum drying, and the addition of gum arabic as a drying aid. In preliminary research, kersen fruit flour was used to formulate biscuits, and the selected product was determined. Formula A2B2 was chosen, substituting 17% kersen flour and 50% low-calorie sweetener. In preliminary research, kersen fruit flour was used to formulate biscuits, and the selected product was determined. Formula A2B2 was chosen, substituting 17% kersen flour and 50% low-calorie sweetener. Dietary fiber content and antioxidant levels were analyzed using puree, flour, and selected biscuits. A sensory and consumption acceptance test was conducted with 30 overweight and obese adult panelists.*

Research Result: *Results showed that kersen flour contained the highest dietary fiber (60.82 mg/100 g), while puree had the highest antioxidant content. Total phenol, flavonoid, and anthocyanin contents declined during processing but remained substantial in the final product. The selected biscuit (A2B2) had lower fiber and energy content than comparable commercial products and was well-accepted (83% overall liking).*

Conclusion: *These findings suggest that kersen fruit flour holds promise as a local functional food ingredient for preventing overweight and obesity. The incorporation of kersen fruit flour into biscuit products was quite acceptable.*

BACKGROUND

The prevalence of overweight and obesity continues to increase globally and has become a significant challenge in public health. World Health Organization (2023) data indicate that more than 1.9 billion adults are overweight, and over 650 million of them are obese. In Indonesia, a similar trend is observed: the prevalence of obesity among adults (>18 years) rose from 21.8% in 2018 to 23.4% in 2023 based on the 2023 Indonesia Health Survey (SKI 2023). Central obesity, characterized by fat accumulation in the abdominal area, reached 36.8% in the same year. Overweight and obesity increase the risk of non-communicable diseases (NCDs) such as type 2 diabetes, hypertension, and cardiovascular disease. Excess adiposity increases oxidative stress and may lead to cellular, tissue, and organ damage, which, if sustained, contributes to NCDs (Savini et al., 2016). Risk is higher among people with overweight/obesity; for instance, Arora et al. (2007) reported that individuals with overweight/obesity have a 2.9-fold higher risk of type 2 diabetes than those with normal weight. Adenan et al. (2020) found that antioxidant status, a marker of oxidative stress, was lower in women with obesity compared to normal-weight women and negatively correlated with cardiopulmonary responses, suggesting that antioxidants may influence cardiometabolic risk stemming from oxidative stress. Consequently, adequate antioxidant intake prevents overweight, obesity, and related NCD risk.

Unhealthy diets—high in calories and low in fiber—along with sedentary lifestyles, contribute substantially to increasing rates of overweight and obesity. Dietary fiber plays a key role in weight control via several physiological mechanisms. High-fiber foods require longer chewing and increase saliva production. Soluble fiber forms a viscous gel in the gastrointestinal tract, slows gastric emptying, and increases satiety, which can reduce overall caloric intake (Astawan & Wresdiyati, 2004). Fiber can reduce energy intake, support weight loss, and prevent weight gain. High-fiber foods also tend to have lower energy density.

Preventive measures in Indonesia include health education, promoting physical activity, and encouraging reduced consumption of high-calorie foods. A complementary approach is modifying dietary patterns by developing low-calorie foods rich in fiber and bioactive compounds. Food-based preventive strategies emphasize nutritious products that are culturally acceptable and well-received by consumers.

Kersen (Muntingia calabura L.) is a tropical fruit with strong potential as a functional food source. It contains bioactive compounds such as flavonoids and phenolics that act as natural antioxidants (Marliyati & Kustiyah, 2020). The fruit is also relatively high in dietary fiber, which can slow glucose absorption, promote satiety, and improve lipid metabolism (Nurdjanah et al., 2021). Despite its potential, research on kersen remains limited, and its use in food products is still scarce. Processing kersen is uncommon; the fruit is usually eaten fresh, baked into cakes, or made into jam (Mahmood et al., 2014).

Using kersen fruit flour in biscuits could deliver functional benefits (dietary fiber and antioxidants) while, together with other ingredients, supporting the development of low-calorie biscuits for preventing overweight and obesity. This aligns with current food trends emphasizing disease prevention, particularly NCDs. Developing functional products from potential local ingredients requires preliminary research to define base formulations and to produce intermediate products—such as kersen fruit flour in this study—using processing methods that preserve nutrient and bioactive profiles. Therefore, this study assessed the dietary fiber and antioxidant potential of kersen fruit flour as an additive in low-calorie biscuits to support obesity prevention in Indonesia and evaluated the product's acceptability in adults with overweight and obesity.

RESEARCH METHODS

This research used an experimental design. The production of kersen fruit flour at PAU SEAFAST (Southeast Asian Food and Agricultural Science and Technology), IPB University. Biscuit production was conducted in the Food Experimentation Laboratory and the Sensory Laboratory, Department of Community Nutrition, IPB University. Analyses of nutrients, dietary fiber, and antioxidant contents of kersen fruit puree, flour, and biscuits were conducted at the Laboratory of Nutrient and Biochemistry Analysis (Department of Community Nutrition, IPB University), Saraswanti Indo Genetech (SIG), and the Testing Laboratory of the Indonesian Center for Postharvest Research and Development.

This study is part of the primary research entitled "Utilization of Kersen (Muntingia calabura L.) Fruit in Biscuits as a Source of Fiber and Antioxidants." The target consumers are overweight and obese adults. Biscuits were formulated with kersen fruit flour and sugar substitution using low-calorie sweeteners. The base formulation references Ajila et al. (2008) with modifications; detailed formulations are available in Silviani et al. (2022).

Analyses of the puree, flour, and biscuits included dietary fiber and antioxidant contents. Nutrient analysis of the selected biscuit comprised moisture (gravimetric; AOAC 2005), ash (gravimetric; AOAC 2005), protein (Kjeldahl; FOSS Tecator Kjeltec 200; AOAC 2005), fat (Soxhlet; AOAC 2005), carbohydrate (by difference; AOAC 2005), and dietary fiber (enzymatic; AOAC Official Methods 991.43, 985.29 [1995]). Quantitative antioxidant analyses used spectrophotometry for total phenols (Folin–Ciocalteu), total flavonoids (AlCl3 colorimetry), and total anthocyanins (cranberry anthocyanin quantification per Fuleki & Francis, 1968; see Lao & Giusti, 2016). Acceptability (hedonic liking of taste, color, aroma, texture, overall) and consumption tests were conducted in 30 adults (male/female, 19–39 years) with BMI ≥ 23 kg/m2 (Asia-Pacific cut-offs; WHO, 2000). Consumption capacity was assessed using the Percentage of leftovers on a modified Comstock scale. The serving size for the selected biscuit matched comparable commercial products.

Data processing and analysis were performed using Microsoft Excel 2010 and SPSS v16.0. Comparisons of dietary fiber and antioxidants across puree, flour, and the selected biscuit used one-way ANOVA (for normally distributed data) and Mann–Whitney (for non-normal data) at α=0.05, followed by Duncan's test when appropriate. Acceptability data were tabulated and described; biscuit nutrient contributions were analyzed descriptively.

RESULT

Production of Kersen Fruit Flour

Kersen fruit contains nutrients, dietary fiber, and antioxidant bioactives and thus has strong potential for product development. However, its use in food products remains minimal. Incorporating fruits/vegetables into dry foods (e.g., biscuits) typically requires a preliminary step of converting the raw material into a powder to extend shelf life and facilitate distribution, storage, and formulation. Losses of nutrients and bioactives can be minimized through appropriate drying methods and the use of suitable encapsulants/drying aids (Jiang et al., 2013). Figure 1 illustrates the production process—sorting, washing, blanching, comminution, drying, and milling—modified from Maigoda (2016).

Figure 1 Production process of kersen fruit flour

Selection of the Optimized Formula

The produced kersen flour was then used in biscuit formulations. The selection was based on six formulations previously developed and evaluated by hedonic testing (Silviani et al., 2022). Kersen flour substitution levels were 11%, 17%, and 22% of total flour; sweetener levels were 40% and 50% of total palm sugar equivalent. Low-calorie sweeteners were a mixture of pure sorbitol and sucralose at a 1:4 ratio, dosed to achieve sucrose-equivalent sweetness. The minimal kersen flour level was derived from the estimated minimum fiber contribution per 100 g to allow a "source of fiber" claim per BPOM (2016): ≥3 g/100 g (solids).

The optimized formula was identified using the Percentage of "liked" responses (hedonic scale). The Liked Percentage is the total Percentage of panelists who rated on a scale of 5 (somewhat like) to 7 (like very much) on the hedonic data of the organoleptic test on semi-trained panelists. This organoleptic test identified across color, taste, aroma, texture, and overall quality of the product. Results are summarized below.

Table 1. Liked the Percentage of each formula

Formula	Parameter				
	color	taste	Aroma	texture	overall
A1B1	60,0	73,3	63,3	76,7	73,3
A2B1	70,0	70,0	56,7	70,0	70,0
A3B1	70,0	60,0	56,7	60,0	60,0
A1B2	66,7	60,0	63,3	63,3	76,7
A2B2	83,3	70,0	56,7	66,7	76,7
A3B2	63,3	66,7	63,3	50,0	60,0

notes :
Formula=(TBK:P). TBK kersen flour. P= sweetener. A1B1= 11% TBK: 40% P, A2B1= 17% TBK: 40% P, A3B1 = 22% TBK: 40% P, A1B2 = 11% TBK: 50% P, A2B2= 17% TBK: 50% P dan A3B2= 22% TBK: 50% P

Formula A2B2 showed the highest liking for color. For taste, A1B1 was highest, followed by A2B2 and A2B1 (tied for second). For overall liking, A1B2 and A2B2 tied at 76.7%. Given that taste is a primary determinant of consumer preference and intake (Setyaningsih et al., 2010), taste and overall liking, together with nutrient composition, fiber, and antioxidant activity (from prior work), supported the choice of A2B2 (17% kersen flour; 50% sweetener) as the optimized formula.

Dietary Fiber and Antioxidants in Puree, Flour, and Biscuits

Kersen fruit naturally contains nutrients, fiber, and antioxidants. Fresh fruit includes 8.11 g dietary fiber, 2820 mg GAE total phenols, and 1855 mg Q flavonoids per 100 g (Marliyati & Kustiyah, 2020).

Table 2. Dietary Fiber and Antioxidant Contents

Parameter	Kersen Puree	Kersen flour	Selected biscuit	P-value
Dietary fiber (mg/100 g)	7,34 ±0,59^{a}	60,82 ± 8,25^{b}	11,5^{a}	0,001
Total phenol (mg GAE/100 g)	399,32 ± 10,15^{a}	236,17 ± 19,6^{b}	119,52 ± 0,72^{c}	0,000
Total flavonoids (mgQ/100 g)	53,15 ± 7,44^{a}	32,61 ± 2,74^{b}	19,79 ± 1,53^{c}	0,001
Total anthocyanins (mg/100 g)	10,02 ± 0,21^{a}	12,31 ± 1,45^{a}	1,62 ± 0,00^{b}	0,002

notes: $^{a-b}$ Different superscript letters within a row indicate significant differences by one-way ANOVA (p<0,05)

Thermal processing generally reduces antioxidants. As shown in Table 2, the puree had the highest levels of phenols and flavonoids, followed by the flour and biscuit. Anthocyanins did not differ significantly between puree and flour, but both were significantly higher than in the biscuit.

Nutrient Composition of the Selected Formula compared to Commercial Products

Biscuits are a significant category in the food industry due to their long shelf life, diverse sensory profiles, and broad consumer acceptance (Arepally et al., 2020). In the table below, the selected biscuits were compared with commercial biscuits in terms of serving sizes.

Table 3. Comparison of Nutrient Content and % Daily Value of the Selected Biscuit vs. Commercial Products

Parameter	Nutritional value			Daily Value (% AKG*)		
	A2B2 (19,5 g)	K1[a] (19,5 g)	K2[b] (20 g)	F5 (19,5 g)	K1[a] (19,5 g)	K2[b] (20 g)
Total energy (kkal)	96	100	100	4	5	5
Energy from fat (kkal)	36	40	50	-	-	-
Protein (g)	1	2	1	2	3	2
Total fat (g)	4	4	6	6	6	9
Carbohydrates (g)	14	13	11	4	4	3
Dietary fiber (g)	2	n/a	1	7	n/a	3
Antioxidants						

*notes: * %DV for adults based on 2150 kcal/day*
*[a]Ro*a Sari Gandum. [b]W*P Cookies*

The biscuits in this study were specially formulated for adults who are overweight or obese. The nutritional composition per serving and contribution to daily dietary requirements of the selected biscuit formula (A2B2) were analysed and compared with similar commercial diet biscuits available on the market (K1 and K2). The nutritional composition and contribution of the selected biscuit formula (A2B2) showed relative similarity to the two commercial diet biscuit products (K1 and K2). The total energy content and energy derived from fat in biscuits A2B2 were lower than in the two commercial products, indicating the potential of these biscuits as a low-energy food alternative. The protein, total fat, and carbohydrate content of biscuit A2B2 is comparable to that of products K1 and K2. However, the notable advantage of biscuit A2B2 is its higher dietary fibre content compared to product K2.

Acceptability

A consumption test of biscuits with the selected formula (A2B2) was conducted on 30 consumer panellists who met the criteria of being overweight and obese, aged between 19 and 39 years. The testing procedure was conducted door-to-door, visiting each panellist directly at their residences. The test series included interviews with short questions, hedonic tests, and assessments of product consumption per serving. The hedonic test covered five sensory attributes: colour, taste, aroma, texture, and overall impression. Based on the interview results, it was found that 17% of the panelists had never consumed cherries before. The panelists were asked to rate their liking for kersen biscuits and their ability to consume the product.

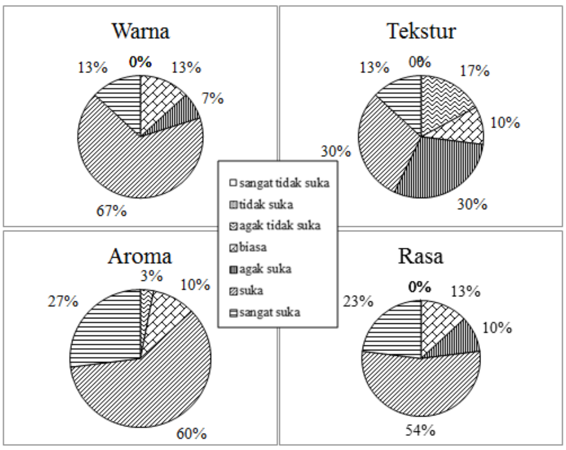


Figure 2: Acceptability of Kersen Biscuit

Most panellists showed a high level of liking for the colour, taste, and aroma attributes of the selected kersen biscuit formula. The cumulative Percentage of panellists who gave ratings in the 'like' and 'very like' categories for the colour, taste, and aroma attributes reached 80%, 77% and 87% respectively.

However, the level of acceptance for the texture attribute was relatively lower, with only 43% of panellists stating that they liked it. As many as 17% of panellists even disliked the product's texture.

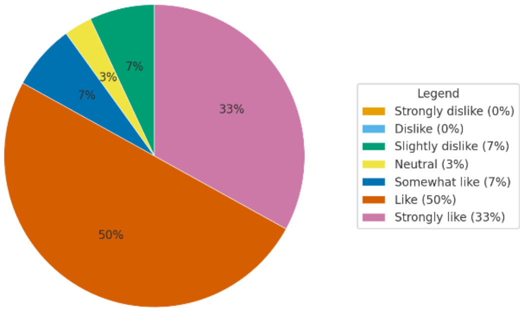
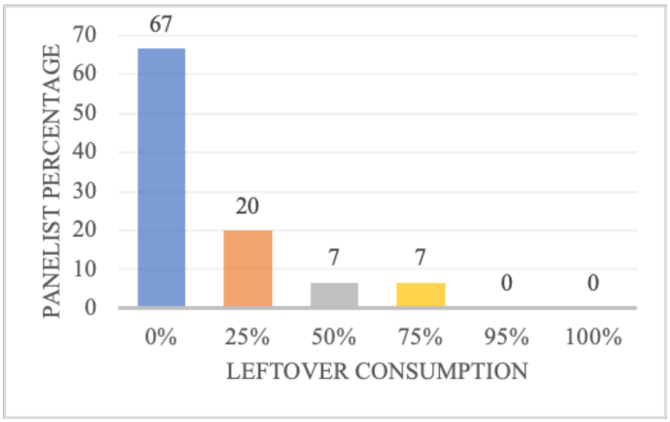


Figure 3: Overall Acceptability of Kersen Biscuit

The assessment results of the overall attributes of the selected kersen biscuit formula show that most panellists responded positively to the product, with a total percentage of liking in the 'like' and 'like very much' categories reaching 83%. Most panellists stated that the biscuits tasted good, although many reported a slightly bitter aftertaste and a hint of sourness. The biscuit's consumption power was evaluated by presenting the product in serving sizes adjusted to the standards of similar commercial products. The serving size of the selected kersen biscuits was determined based on the serving size of similar commercial products commonly consumed by the public. The commercial biscuit serving size referred to was 19.5 g. Panelists were given three biscuits, each weighing approximately ±6 grams. Using a modified Comstock scale, consumption levels were measured based on the Percentage of biscuits not consumed.



notes: 0%= no leftovers, 25%= 1/4 leftover, 50%= 1/2 leftover, 75%= 3/4 leftover, 95%= almost whole, 100%= not consumed

Figure 4: Leftover consumption levels

The graph above shows that 67% of panellists consumed all of the Kersen biscuits without leaving any leftovers. Meanwhile, 20% of panellists consumed three-quarters of the biscuits, meaning 87% could drink at least three-quarters of the serving size.

DISCUSSION

Each stage of kersen flour production was designed with reference to prior research to minimize nutrient loss and preserve bioactive compounds. Ripe fruits were sorted, washed, frozen at −20°C, thawed, steam-blanched at 100°C for 3 minutes, then rapidly cooled with running water to stop heating. Steam blanching was chosen to protect antioxidants. Rossi et al. (2003) found that 3-minute steam blanching better preserved phenolics and DPPH antioxidant activity in blueberry juice than no blanching, and Brambilla et al. (2011) reported only a 17.6% loss in monomeric anthocyanins in blanched blueberry puree, versus much larger losses without blanching.

Puree was prepared by blending (medium speed, 2 minutes) to homogeneity, followed by the addition of gum acacia (gum arabic) at 15% (w/w) and water at 50% of the fresh fruit weight. Fruit-based powders differ from starch-based flours due to high levels of low-molecular-weight sugars (sucrose, fructose, glucose) with low glass transition temperatures, which cause stickiness during drying. Therefore, high-molecular-weight carriers (maltodextrin, gum arabic/acacia, protein isolates) are often used as drying aids to reduce stickiness and improve drying efficiency and product quality (Comunian et al., 2011). Gum acacia was chosen for its low energy value compared with starch- or protein-based carriers.

Drying was performed using a vacuum evaporator at ~50°C under vacuum (≈ - −74 mmHg), modified from Šumić et al. (2015), who reported optimal vacuum-oven drying of blueberries at 60°C and 100 mbar. Low-temperature, vacuum conditions were selected to reduce thermal/oxidative degradation of antioxidants (Estiasih & Ahmadi, 2011). The dried product was milled and sieved (40-mesh).

Figure 5: Vacuum Evaporator

The flour-making process preserved a meaningful portion of antioxidant bioactives through the final biscuit product, despite the long thermal processing (drying + baking) that typically degrades antioxidants. At the same time, fiber remains relatively stable (Karam et al., 2016). Dietary fiber in the flour was partly attributable to gum acacia—a mixture of polysaccharides and glycoproteins from Acacia senegal/seyal that contains ~80% dietary fiber (Mariod, 2018). Thus, fiber in the final biscuit reflects kersen and gum acacia contributions.

Gum arabic has been associated with anti-obesity effects (Ushida et al., 2011). Antioxidant contents (anthocyanins and activity) in fruit powders prepared with gum arabic were comparable to those with maltodextrin (Tonon et al., 2010). Prior work showed that gluten-free cookies with 5% gum arabic had favorable antioxidant levels and were acceptable to consumers (Shahzad et al., 2020). In this study, some texture shortcomings lower hardness/crispness (Silviani et al., 2022) may relate to the relatively high level of kersen flour (containing gum acacia).

Across product forms, total phenols and flavonoids were highest in puree, flour, and biscuits. At the same time, anthocyanins did not differ between puree and flour but were lower in biscuits—consistent with heat/oxygen-sensitive phenolics (Mullen et al., 2007). Kersen flour (236.17 mg GAE/100 g) had higher total phenols than red dragon fruit flour (157.34 mg/100 g; Maigoda, 2016) under similar drying conditions. Combining steam blanching with vacuum drying and gum acacia likely helped reduce antioxidant loss by limiting exposure to oxygen and high temperatures. Although statistical tests showed significant differences, the overall trend suggested that declines in phenols, flavonoids, and anthocyanins were not drastic across the three product forms, supporting the processing choices used here.

The optimized A2B2 formula fulfilled sensory preferences and offered favorable functional attributes relative to other formulations. The A2B2 biscuit compared well with commercial products and, nutritionally, provided energy, protein, fat, carbohydrates, and fiber, alongside natural antioxidants from kersen. Future work should target texture and aftertaste (some panelists reported that it is somewhat firm/less crisp, slightly bitter, and mildly sour). Reformulation may improve sensory quality while maintaining nutritional and functional benefits.

This work also highlights concerns with typical commercial biscuits, often high in fat and sugar but low in fiber and antioxidants. In Indonesia, consistently high energy/fat intakes are significantly associated with overweight/obesity among adults (Khusun et al., 2016). Overconsumption of such foods can increase weight gain and long-term NCD risk. The present study contributes to preventive strategies by documenting the potential of kersen fruit flour, the processing approach, and its application in a functional food product, thereby expanding healthier snack options.

CONCLUSIONS

Kersen fruit flour (Muntingia calabura L.) has potential as a functional food ingredient rich in fibre and antioxidants, and it can be used to develop low-calorie biscuits to prevent overweight and obesity. The kersen fruit flour production process can retain most bioactive compounds, despite some loss during production. The selected biscuit formula (A2B2) has lower energy content than similar commercial products, but has higher dietary fibre content and is enriched with antioxidants. Overall, the selected biscuits are well accepted by the target group of overweight and obese individuals.

RECOMMENDATION

Further studies should optimize the biscuit's texture and crispness, address aftertaste, explore alternative drying aids, and evaluate longer-term metabolic effects in adults with overweight or obesity.

REFERENCES

Adenan DM, Jaafar Z, Jayapalan JJ, Aziz AA. Plasma antioxidants and oxidative stress status in obese women. Correlation with cardiopulmonary response. PeerJ. 8.e9230. 2020

Arora M, Koley S, Gupta S, Sandhu JS. A study on lipid profile and body fat in patients with Diabetes Mellitus. Anthropol. 2007. 9(4).295–298. doi. 10.1080/09720073.2007.11891015.

Astawan M, Wresdiyati T. Diet Sehat dengan Makanan Berserat. Tiga Serangkai. Solo. 2004

Boobier WJ, Baker JS, Davies B. Developing a healthy biscuit: an alternative approach to biscuit manufacture. Nutr J. 7.1–7. 2006. doi. 10.1186/14752891-5-7.

Brambilla A. Maffi D., Rizzolo A. Study of the influence of berry-blanching on syneresis in blueberry purées. Procedia Food Sci. 2011. 1 December. 1502–1508. doi.10.1016/j.profoo.2011.09.222.

Comunian T, Monterrey-Quintero ES, Thomazini M, Balieiro JC, Piccone P, Pittia P, Favaro-Trindade C. Assessment of production efficiency, physicochemical properties and storage stability of spray-dried chlorophyllide, a natural food colourant, using gum Arabic, maltodextrin and soy protein isolate-based carrier systems. International Journal of Food Science & Technology. 2011. 46. 1259–1265. 10.1111/j.1365-2621.2011.02617.x.

Estiasih T, Ahmadi K. Teknologi Pengolahan Pangan. Bumi Aksara. Jakarta. 2011.

Jiang H, Zhang M, Adhikari B. Fruit and vegetable powders. Di dalam. Handbook of Food Powders. Processes and Properties. Cambridge (UK). Woodhead Publishing Limited. 2013. hlm 532–552.

Karam MC, Petit J, Zimmer D, Baudelaire Djantou E, Scher J. Effects of drying and grinding in fruit and vegetable powders production. A review. Journal of Food Engineering. 2016. 188, pp.32–49. doi.10.1016/j.jfoodeng.2016.05.001.

[Kemenkes RI] Kementerian Kesehatan Republik Indonesia. Survei Kesehatan Indonesia 2023. Jakarta. Badan Kebijakan Pembangunan Kesehatan, Kementerian Kesehatan Republik Indonesia. 2023

Khusun, H., Wiradnyani L, Siagian N. Factors associated with overweight/obesity among adults in urban Indonesia (Faktor-faktor yang terkait dengan obesitas pada orang dewasa di perkotaan Indonesia. J Nutr Food Res. (2016). 38.95-110. 10.22435/pgm.v38i2.5539.

Lao F, Giusti MM. Quantifying purple corn (Zea mays L.) anthocyanins using spectrophotometric and HPLC methods comparison and correlation. Food Anal Methods. 2016. 9. doi. 10.1007/s12161 015-0318-0.

Mahmood N, Anwar F, Abbas M, Saari N. Effect of maturity on phenolics (phenolic acids and flavonoids) profile of strawberry cultivars and mulberry species from Pakistan. International Journal of Molecular Sciences. 2014. 15(1), pp.1230–1243.

Maigoda TC. Pengaruh Tepung buah naga merah (Hylocereus polyrhizus) dan olahraga renang terhadap penanda inflamasi, stres oksidatif dan kebugaran pada tikus jantan (Sprague dawley) dengan obesitas. Disertasi. Institut Pertanian Bogor, Bogor. 2016.

Mariod, AA. Gum Arabic Dietary Fiber. Di dalam. Gum Arabic. Structure, Properties, Application, and Economics. London (UK). Academic Press. 2018. hlm 237–243.

Marliyati SA, Kustiyah L. Kajian Buah Kersen sebagai Pangan yang mempunyai Potensi untuk Mencegah Penyakit Diabetes Mellitus dan Aterosklerosis [laporan penelitian]. Bogor. IPB University. 2020.

Mullen, W., Marks, S.C. & Crozier, A., Evaluation of phenolic compounds in commercial fruit juices and drinks. Journal of Agricultural and Food Chemistry. 2007. 55(8), pp.3148–3157.

Nurdjanah S, Risnawati, Widyaningsih TDP. Kandungan senyawa bioaktif dan aktivitas antioksidan ekstrak metanol buah kersen. Jurnal Ilmu Farmasi Indonesia. 2021. 19(1), pp.1–10.

Rossi M, Giussani E, Morelli R, Lo R, Nani RC, Torreggiani D. Effect of fruit blanching on phenolics and radical scavenging activity of highbush blueberry juice. Food doi. 10.1016/j.foodres. 2003. 2003.07.002.

Savini I, Gasperi V, Catani MV. Oxidative Stress and Obesity. Di dalam. Obesity. A Practical Guide. Ahmad SI, Imam SK, editor. Switzerland. Springer International. 2016. hlm 65–86.

Setyaningsih D, Apriyantono A, puspita sari M. Analisis Sensori untuk Industri Pangan dan Agro. Bogor. IPB Press. 2010.

Shahzad AS, Hussain S, Mohamed AA, Alamri MS, Qasem AA, Ibraheem MA, Almaiman SAM, Serag El-Din MF. Gluten-free cookies from sorghum and Turkish beans. Effect of non-conventional and commercial hydrocolloids on technological and sensory attributes. Ciência e Tecnologia de Alimentos. 2020. 41, e25419.

Silviani D., Marliyati, S.A. & Kustiyah, L. Pengaruh Pemanfaatan Tepung Buah Kersen (Muntingia calabura L.) dan Substitusi Gula terhadap Kandungan Gizi, Antioksidan dan Organoleptik Biskuit. Media Gizi Indonesia. 2022. 17(1), 33–42.

Šumić ZM, Tepić AN, Jokić SD, Malbaša R V. Optimization of frozen wild blueberry vacuum drying process. Hem Ind. 2015. 69(1).77–84. doi. 10.2298/HEMIND131212022S.

Tonon RV, Brabet C, Hubinger MD. Anthocyanin stability and antioxidant activity of spray-dried açai (Euterpe oleracea Mart..) juice produced with different carrier agents. Food Research International. 2010. 43(3), pp.907–914.

Ushida K, Hatanaka H, Inoue R, Tsukahara T, Philips G. Effect of long-term ingestion of gum arabic on the adipose tissues of female mice. Food Hydrocolloids. 2011. 25, pp.1344–1349.

[WHO] World Health Organization. Regional Office for the Western Pacific. The Asia Pacific Perspective. Redefining Obesity and Its Treatment. Sydney. Health Communications Australia. 2000.