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Exploring the Significance and Medicinal Potential of Rubus fraxinifolius: A Review of Ragimot Wildberry

Muhamad Hanif Rawi[1]

1 Universiti Malaysia Sabah

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Abstract

The rainforests of Sabah, Malaysia, are home to a diverse array of plant life, including the Ragimot berry (*Rubus fraxinifolius*). This berry, belonging to the Rubus genus, is nutritionally rich and holds important cultural and medicinal significance. Traditionally, Rubus species have been known for their various medicinal properties, such as anti-inflammatory, antioxidant, anti-tumor, and neuroprotective effects. The Ragimot berry contains high levels of sugar, vitamin C, and iron, contributing to its health-promoting qualities. It also exhibits strong antioxidant activity and potential as an anti-acetylcholinesterase and antibacterial agent, suggesting its use in managing neurodegenerative diseases and as a natural antimicrobial substance. Efforts are currently underway to domesticate Ragimot through research focused on optimizing cultivation practices. Scientists are studying the best timing and dosage for fertilizer application and exploring methods for large-scale propagation through in vitro germination and plant regeneration strategies. The goal of this research is to conserve this unique plant species endemic to Borneo and provide economic benefits to local communities. To summarize, Ragimot is a valuable plant found in Sabah's rainforests. It is rich in nutrients and has functional properties that make it promising for future use. More research is needed to fully understand its health benefits and promote responsible use. Ragimot serves as a reminder of the importance of protecting biodiversity while utilizing it for a healthier and more sustainable world.

Introduction

In the lush rainforests of Sabah, Malaysia, thrives a hidden gem – the ragimot, a wild berry with a rich history and promising potential. This chapter aims to explore the nutritional composition and functional properties of ragimot, shedding light on its significance in the domains of food and medicine. As global interest in natural and sustainable resources continues to rise, understanding the attributes of ragimot becomes crucial for both local communities and the broader scientific community. Known as *rogimot* (pronounced differently due to Dusun and Kadazandusun dialect influences) in Sabah, this berry is favoured by climbers despite its somewhat tasteless reputation. It belongs to the Rubus subgenus *Ideobatus*, and its fruits are sold in markets and made into jams, particularly in Java (Lamb, 2019). More than eight species of Rubus are found above 1200 m on Mount Kinabalu (Corner & Beaman, 1996), including *Rubus fraxinifolius*. Local variations of rogimot come in two forms: one is red and oval-shaped, and the second is red and round-shaped. However, for this chapter, the focus is on the former, *Rubus fraxinifolius*. The Rubus genus, encompassing 740 species within Rosaceae, has a remarkable presence on six continents, thriving in diverse habitats. Within the Malesia Region, 46 Rubus species were discovered. One of these is *R. fraxinifolius*, a wild raspberry variant. It is found in Sabah's mountainous forests, particularly in the regions around Mount Kinabalu (Shamsudin et al., 2019). Interestingly, the traditional medicinal application of Rubus in Southeast Asia closely mirrors its use in Europe. Numerous Rubus species have been recognized for producing diverse compounds that exhibit pharmacological properties, such as antidiabetic, antibacterial, anti-inflammatory, antioxidant, antidiarrheal, anti-tumor, neuroprotective, and wound-healing effects. Efforts to domesticate the plants are underway by small farmers in Kundasang, Sabah. While the Cibodas Botanical Garden in Jakarta, Indonesia, a hub for ex situ conservation, has amassed eleven Rubus species, including *R. fraxinifolius* (Dewi et al., 2019). Based on data collected from the Cibodas Botanical Garden, *arben* (the common name known in Indonesia) is available throughout the year, with its peak season occurring from January to March (Surya & Rahman, 2012). The flowering and fruiting patterns of the plants correlate positively with environmental factors, such as monthly relative humidity. This observation aligns with the fluctuating availability of ragimot in Kundasang, Sabah, depending on the wet seasons in the area. In the realm of the animal kingdom, the babirusa, a swine-related mammal, feeds on the fruits of ragimot found in Maluku, Indonesia (Macdonald et al., 2023). The ragimot berry (*Rubus* spp.) itself is an erect shrub, standing 2-3 meters tall and adorned with up to 6 mm prickles on its stems. Its pinnate leaves hold 4 pairs of opposite leaflets and a terminal one. These elliptic leaflets, spanning 2-9 x 1.4 cm, sport serrated edges and are sparsely covered in hair, with 7-10(-15) vein pairs (Lamb, 2019). Inflorescence panicles, measuring 6-20 cm long, bear grayish yellow-green flowers with bulging forms (Normasiwi et al., 2021). The small drupes, ranging in color from orange to red, cluster on a central stalk and can measure up to 2.5 x 1.5 cm, each containing a tiny seed. The ragimot's range extends from Taiwan (Huang & Hu, 2009), the Philippines, and Borneo to Sulawesi, Lawu Mountain in East Java (Hidayah & Roziaty, 2022), New Guinea, the Solomon Islands, and even Le Pouce Mountain Reserve in Mauritius, albeit in low abundance (Bissessur et al., 2023).

Nutritional composition

Ragimot is a species of wild raspberry found in the mountainous forests (Desmiaty & Elya, 2021). The berry is valued for its taste, medicinal properties, and nutritional composition (Jansen-Alves et al., 2021). Ragimot is rich in phytochemicals, which are bioactive compounds that contribute to its health-promoting properties. The fruit of Ragimot has been found to have a high content of sugar, vitamin C, and iron (Surya et al., 2018). Specifically, it has been reported to contain 5.05 g of sugar per 100 g of fruit, which is higher than other species (*R. rosifolius, R. chrysophyllus, R. pyrofolius*, and *R. idaeus*) of wild Rubus (Surya et al., 2018). In terms of vitamin C content, Ragimot has been found to have the highest amount (83.65 mg/100 g) during the ripening fruit stage II (Surya et al., 2018). Additionally, it has been reported to have a considerable content of iron (Surya et al., 2018). In terms of phytochemical composition, Ragimot has been found to contain total phenolics, flavonoids, and carotenoids (Bakar et al., 2016). These phytochemicals contribute to the antioxidant activity of the fruit. Antioxidants play a crucial role in protecting the body against oxidative stress and reducing the risk of chronic diseases (Bakar et al., 2016). The antioxidant activity of Ragimot has been evaluated using various assays, including the 1,2-diphenyl-2-picrylhydrazyl (DPPH), iron-reducing antioxidant power (FRAP), and 2,2-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid) (ABTS) assays (Bakar et al., 2016). These assays measure the ability of the fruit extract to scavenge free radicals and inhibit oxidative damage. Furthermore, Ragimot has been found to have anti-acetylcholinesterase and antibacterial activities (Bakar et al., 2016). These activities suggest potential therapeutic applications of the fruit in the treatment of neurodegenerative diseases and as a natural antimicrobial agent. Extracts from the leaves contain alkaloids, flavonoids, hydrolyzed tannins, saponins, and triterpenoids (Sulistyowati et al., 2023). Based on the data, the old leaves yield a significantly higher amount of phytocompounds than the younger leaves. These natural antioxidants scavenge free radicals, helping to combat oxidative stress when used as an antiaging agent. As reported by Dewi et al. (2019) in *Rubus fraxinifolius* Hayata, fresh leaves had a higher content of phenolics and flavonoids and antioxidant capacity than dry leaves, but the α-glucosidase inhibitory activity was higher in air-dried leaves.

Functional properties

Ragimot stands out as an extraordinary fruit that has garnered substantial interest due to its exceptional nutritional composition and potential health advantages. This indigenous Borneo plant, cherished for its year-round harvestability, has emerged as a critical source of income for local communities in Sabah. The fruit's remarkable attributes, such as its elevated sugar, vitamin C, and iron content, not only contribute to its nutritional value but also position it as an invaluable dietary addition (Wardah et al., 2022). *Rubus fraxinifolius* holds deep ethnomedicinal significance, as indigenous communities, such as the Kankanaeys and Kalanguyas in the Philippines, have incorporated the berry into their dietary practices and traditional treatments (Bersamin et al., 2021; Galvez, 2015; Gomez Jr et al., 2023). For instance, the Kalanguyas utilize crushed leaves for managing sore eyes and wounds, while root, leaf, and trunk decoctions are employed to address issues like diarrhea and urinary tract infections (Gomez Jr et al., 2023). This multifaceted plant is being explored from various angles, including its stems, leaves, and fruits, revealing anthocyanin, ellagitannin, proanthocyanin (Desmiaty et al., 2019), and potent triterpenoids with inhibitory actions. These triterpenoids contribute to the plant's elastase inhibitory activity, expanding our comprehension of its bioactive potential (Desmiaty et al., 2020).

Beyond its nutritional richness, *R. fraxinifolius* offers an array of functional properties that promote well-being. Both its leaves and fruits exhibit remarkable radical scavenging activity, showcasing its potential as a natural reservoir of antioxidants (Desmiaty et al., 2018). This prowess in scavenging free radicals is attributed to the abundant polyphenols and flavonoids present in Ragimot. These compounds possess potent antioxidant capabilities that contribute to the fruit's potential role in traditional medicines and anti-aging cosmetics. Notably, recent studies (Sulistyowati et al., 2023) emphasize the efficacy of old leaves in displaying superior antioxidant and elastase inhibition activity when compared to their younger counterparts. These findings suggest the feasibility of harnessing *R. fraxinifolius* leaves as an active ingredient in anti-aging cosmetic formulations. The fruit's potent ability to scavenge radicals has been demonstrated through the FRAP and DPPH methods, underscoring its antioxidant potential (Desmiaty & Elya, 2021). The rich reservoir of polyphenols in the fruit contributes significantly to this antioxidant capacity, positioning *R. fraxinifolius* as a superior candidate in comparison to other Rubus species (Bakar et al., 2016). *R. fraxinifolius* stands out for its potential as an anti-aging agent, demonstrating anti-elastase and anti-tyrosinase activities that are pivotal in thwarting skin aging (Desmiaty et al., 2020). These attributes render it a promising contender for incorporation into cosmetics and skincare formulations aimed at preserving youthful skin. Furthermore, the species showcases nutritional prowess, boasting elevated sugar, vitamin C, and iron content, setting it apart from other Rubus counterparts (Surya et al., 2018). Amid its diverse functional properties, *R. fraxinifolius* has also been investigated for its antibacterial potential. While some Rubus species exhibit varying inhibitory effects on different bacterial strains (Bakar et al., 2016), as shown by Galvez et al. (2016), ragimot showed antibacterial potential against *Bacillus cereus*. *R. fraxinifolius*'s antibacterial properties underscore its versatility and multifaceted contributions. In the realm of scientific inquiry, *R. fraxinifolius* has emerged as a captivating subject, revealing a wealth of functional attributes that span from antioxidant and anti-aging potential to antibacterial efficacy. These revelations herald a new era of exploration into the possibilities that this remarkable plant holds across domains as diverse as medicine, cosmetics, and dietary enhancement. As we unravel its mysteries, *R. fraxinifolius* cements its place as an invaluable botanical treasure.

Efforts on cultivation

Addressing the urgent need to conserve a rapidly declining Borneo-endemic plant species, Ragimot, has prompted extensive research efforts (Bissessur et al., 2023). In pursuit of this mission, recent studies have investigated various aspects of Ragimot cultivation. Notably, a groundbreaking approach centered on optimizing fertilizer application time and dosage has been undertaken to domesticate and cultivate Ragimot as a highly promising fruit crop (Noviady et al., 2022). This endeavor builds upon prior research, which had already identified compost as the optimal planting medium, demonstrating its efficacy across multiple parameters (Surya, 2012).

In the context of *Rubus rosifolius* Sm. and *R. fraxinifolius* Poir., their growth responses to combinations of fertilizer doses and application timings have been scrutinized across several research articles. Diving into this field, Ismaini et al. (2017) investigated micropropagation methods for Rubus chrysophyllus and *R. fraxinifolius*. The study revealed distinct responses to a medium containing 10 mg/L of IBA, with *R. fraxinifolius* displaying superior results in terms of root length and numbers compared to *Rubus chrysophyllus*. Building on this foundation, Noviady et al. (2022) delved into the growth and development responses of *Rubus rosifolius* Sm. and *R. fraxinifolius* Poir. to the interplay of fertilizer doses and application timings. Strikingly, their findings showcased the prominence of combinations such as *R. rosifolius* + K3 and *R. fraxinifolius* + K4, leading to elevated fruit yield in terms of number, size, and weight per plant.

These comprehensive investigations underscore the pivotal role played by fertilizer doses and application timings in shaping the growth and development of Rubus species. The revelations offer a valuable blueprint for optimizing productivity and profitability in fruit crop cultivation, particularly focusing on *Rubus rosifolius* Sm. and *R. fraxinifolius* Poir. (Ismaini et al., 2017; Guo et al., 2021; Noviady et al., 2022).

Given the imperative for large-scale plantlet production for commercial purposes, there's a pressing demand for efficient and cost-effective methods. Presently, the propagation of *R. fraxinifolius* predominantly relies on seedlings growing within the garden. However, this conventional approach is time-intensive, as observed by Surya (2012), with seedling heights ranging between 0.96 – 3.56 cm within 12 weeks after sowing. In contrast, the in vitro germination method, as noted by Surya et al. (2015), offers a swifter alternative. Ismaini and Surya (2017) have also explored diverse plant regeneration avenues, honing in on *R. fraxinifolius* hypocotyls. Their research aimed at optimizing the regeneration process through the assessment of various growth regulators' impact on callus dimensions, leaf numbers, plantlet traits, and root counts. Encouragingly, the results underscored the efficacy of medium 3, comprising 0.5 mg/L GA3, 2.5 mg/L 2-iP, and 0.1 mg/L NAA, in driving the development *of R. fraxinifolius* explants (Ismaini & Surya, 2017). Importantly, the concentrations of 2-iP and NAA were found to wield a significant influence on the regenerative process.

Beyond its medicinal applications, Ragimot holds multifaceted value for local communities in the Barangays, Philippines. This diverse utility spans offerings such as condiments like jam, jellies, candies, juice, wine, as well as its employment in dyes and decorations (Chua-Barcelo, 2014). As research continues to illuminate the potential of this species, its significance transcends boundaries, promising both ecological preservation and economic enrichment.

Conclusion

Ragimot, the wild berry of Sabah, stands as a testament to the wealth of natural resources harbored within the world's rainforests. Its nutritional composition, packed with phytochemicals, vitamins, minerals, and dietary fibre, bestows an array of functional properties that can benefit human health. The antioxidant and anti-inflammatory capabilities of Ragimot hold promise in combating various diseases, while its potential to support the immune system and cardiovascular health further solidifies its value as a functional food. Additionally, its role in managing blood sugar levels indicates potential applications in diabetes management. As we embrace a holistic approach to health and nutrition, incorporating traditional and local fruits like Ragimot into our diets may pave the way towards a healthier, sustainable future. However, further research and studies are warranted to unravel the full extent of Ragimot's health benefits, ensuring its responsible use and conservation for the benefit of current and future generations. In conclusion, Ragimot serves as a vibrant reminder of the treasure trove of natural goodness found within our planet's biodiversity, urging us to preserve these precious resources while harnessing their potential for a healthier and thriving world.

Figures and Tables

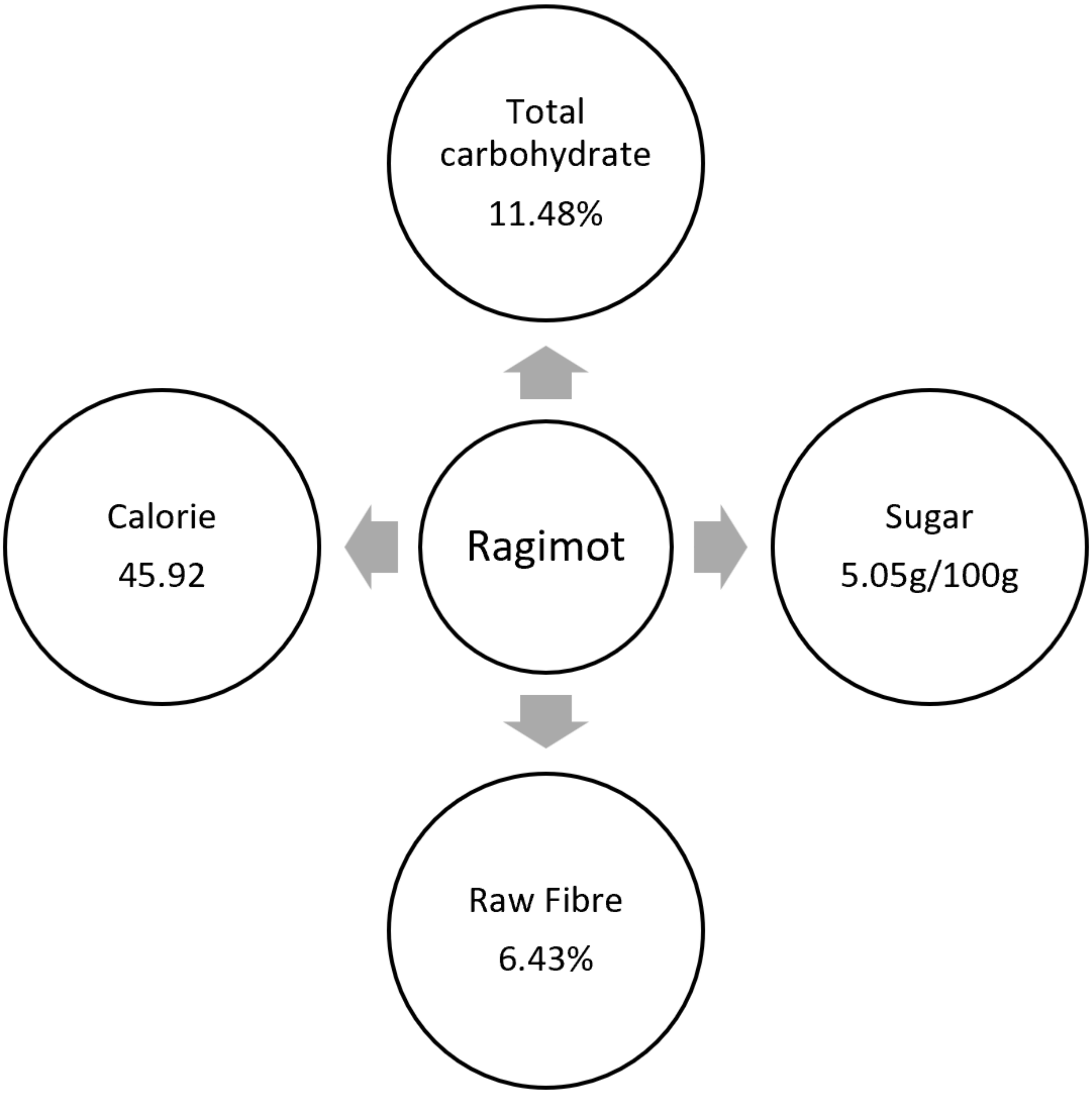

Figure 1. Nutrient analysis of Ragimot fruits (Surya et al., 2018)

Figure 2. Freshly harvested Ragimot (Sulap Dahai, 2021)

Figure 3. Ragimot berry may as well resemble raspberry drupes

Table 1. Phytochemical components of ragimot potential for medicinal applications

Chemical compounds	References
2-propenoic acid; 2-propenyl esters	(Abu Bakar et al., 2016)
2,6-dihydro-xypyridine (6-hydroxy-2(1H)-pyridinone)	
1,1,2-triacetoxyethane	
3-deoxy-d-mannoic lactone furfural	
1,3-butadiene-1-carboxylic acid	
2,4-dihydroxy-2,5-dimethyl-3(2H)-furan-3-one	
2,3-O-ethyleneglycol,19-hydroxyurs-12-en-23,28-dioic acid	(Desmiaty et al., 2021)
2,3-O-propanediol,19-hydroxyurs- 12-en-28-oic acid	

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