Kelor (*Moringa Oleifera* Lam.): Cultivation, Benefit, and Economic Potential

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Abstrak
Moringa (*Moringa oleifera* Lam) contains various nutrients including vitamins, minerals, amino acids and other phytochemicals that are beneficial for health. Moringa leaves have long been known as medicine because of their high antioxidant content. In Indonesia, Moringa leaves are starting to be widely used in the food and beverage industry, health and other industries. Moringa plants are easy to cultivate. With a touch of innovation in the growing media, the growth of Moringa plants shows better growth. For example, the use of husk charcoal, cocopeat, and compost. In the food sector, Moringa leaves can be applied to meat products, milk and flour-based products. The processing of various kinds of processed Moringa products is carried out with the aim of providing added value, both economically and in volume. Moringa's economic potential through increasing added value needs to be managed on a large scale, in this case, Moringa agroindustry, which is an industry that processes Moringa commodities into processed products.

Keywords: agroindustry, antioxidant, Moringa

Introduction

(*Moringa oleifera* Lam) is known by various local names in various parts of the world, such as kelor, moringa, sajna, saijihan, marango, sohanjana or sahjan. This type of annual plant is widely developed and grows well in areas with tropical climates with high humidity and hot and dry areas (Sohaimy, Hamad, Mohamed, Amar, & Al-hindi, 2015). Some parts of the Moringa plant can be used for various purposes including for medicine and food production. The leaves, flowers and seeds are commonly used as vegetables and animal feed (Khalafalla et al., 2010).

Moringa leaves have many benefits for humans because of their antioxidant and antimicrobial content, including phenols, flavonoids, ascorbic acid, peptides and carotenoids (Jayawardana, Liyanage, Lalantha, Iddamalgoda, & Weththasinghe, 2015). Moringa leaves contain high-quality protein and amino acids that are easy to digest. Another benefit of Moringa leaves can overcome the problem of malnutrition, especially in infants and nursing (Busani Moyo, Masika, Hugo, & Muchenje, 2011). In the world of medicine, Moringa leaves are commonly used for the treatment of anemia, skin infections, asthma, diarrhea, cholera, respiratory disorders, intestinal infections and diabetes (Salem, Salama, & Ragab, 2015). Jayawardana et al. (2015) found the effect of adding Moringa leaf flour to meat products that can extend shelf life.

In addition to having health benefits, additional food made from moringa has innovation benefits, environmental benefits in the form of potential carbon absorption, and economic benefits in the form of additional income potential (Amini, Kriswantriyono, Syarief, Hidayat, & Solekhah, 2021). In a pandemic situation like today, the widespread use of Moringa leaves to maintain endurance through application to food is very reasonable. This paper focuses on a review of Moringa leaves, especially their nutritional content, benefits in the food sector and their economic potential.

Moringa morphology

The plant comes from South Asia such as India, Pakistan, Sri Lanka and Bangladesh. The plants belonging to the Moringaceae family are also widely spread in Southeast Asia such as Vietnam, Malaysia, Thailand and Indonesia (Edwinanto, Septiadi, Nurfazriah, Anastasya, & Pranata, 2018). Moringa can grow in sub-tropical areas with temperatures of 1-3°C and tropical areas with temperatures of 38-48°C in both winter and summer (Mahmood, Mugal, & Haq, 2010).

Moringa is an *evergreen* plant that is green throughout the year and can grow up to 10-12 meters. The characteristics of the leaves are *bipinnate* or more often *tripinnate* with a length of up to 45 cm arranged alternately and spirally on the twigs. The leaves are relatively small (1-3 cm long and 4-10 mm wide) and are light green to green in color. The tip of the leaf is blunt, while the base of the leaf is rounded with a flat leaf edge. The flowers are fragrant, bisexual and yellowish white with a green midrib (Roloff, Weisgerber, Lang, & Stimm, 2009). Moringa leaf shape can be seen in Figure 1. Moringa plants have the following taxonomic system (Cronquist 1981 dalam Edwinanto et al., 2018):

Kingdom : Plantae
Subkingdom : Tracheobionta (vascular plant)
Super division : Spermatophyta (seed plant)
Division : Magnoliophyta (flowering plant)
Class : Magnoliopsida (dicots)
Subclass : Dilleniidae
Order : Capparales
Family : Moringaceae
Genus : Moringa
Species : *Moringa oleifera* Lam

Gambar 1. Karakteristik daun kelor

Nutritional and bioactive content

Almost all parts of the Moringa plant can be used: roots, bark, leaves, sap, seed pods, flowers have been widely used as ingredients in traditional medicines, especially in South Asia. The Moringa plant is also referred to as the "miracle tree" because of its benefits as a medicinal ingredient as well as functional food, especially its leaves (Moyo, Masika, & Muchenje, 2012). The nutritional and functional content of Moringa leaves can be seen in Table 1.

Table 1. Types of nutritional and phytochemical content of dried Moringa leave

Nutrition	Types of nutrition	References
Vitamin	Vitamin A (β-carotene) Vitamin C Vitamin E Vitamin B1 (Thiamin) Vitamin B2 (Riboflavin) Vitamin B3 (Nicotinic acid)	(Sohaimy et al., 2015)
Mineral	Sodium Potassium Magnesium Phosphorus Iron Zinc Copper Calcium Manganese	(Sohaimy et al., 2015; Mouminah, 2009)
Amino acids	Arginine Serine Aspartic acid Glutamic acid	(Moyo et al., 2011)

	Glycine Threonine Alanine Tyrosine Proline Methionine Valine Phenylalanine Leucine Isoleucine Histidine Cysteine Tryptophan	
Phytochemicals	Tannin gallic Tannin catechol Steroid dan triterpenoid Flavonoid Saponin Anthraquinone Alkaloids Polyphenols	(Sahay, Yadav, & Srinivasamurthy, 2017)

The study of (Sahay et al., 2017) has investigated the nutritional content of fresh and dried Moringa leaves, as seen in Table 2

Table 2. The nutritional content of fresh Moringa leaves and dried Moringa leaves (per 100 gr)

Nutrition	Unit	Fresh leaves	Dried leaves
Water content	%	95,9	6
Energy	Kcal	92	271,54
Protein	gr	6,7	23,78
Carbohydrate	gr	12,5	28,32
Fat	gr	1,7	7,014
Fiber	gr	0,9	11,8
Vitamin C	mg	220	56
Betacarotene	µg	6780	37800
Iron	mg	0,85	19
Calcium	mg	440	3467
Phosphor	mg	70	215

Irwan (2020) reported that in the process of making Moringa leaf flour using traditional drying methods, namely blanching, withering, and drying produced the highest content of protein was 28.66 gr, phosphorus 715.32 mg, and zinc 2.32 mg by means of the blanching drying method. While the highest Ca and Fe contents were obtained by withering drying method with Ca 1014.81 mg and Fe 11.41 mg (Table 3).

Table 3. Moringa leaf nutrition by drying method per 100 grams (Irwan, 2020)

Nutrition	Drying methods		
	Blanching	Withering	Drying
Protein (gr)	28.66	27.83	26.65
Ca (mg)	929.29	1014.81	962.28
P (mg)	715.32	700.65	445.18
Fe (mg)	9.99	11.41	4.95
Zn (mg)	2.32	2.16	2.01

The content of chemical compounds or bioactive compounds in Moringa leaf extract has several health benefits, including antioxidant, antimicrobial, anti-inflammatory, anticancer and antiatherosclerosis. The anticancer effect is thought to be produced by the phytochemical content of flavonoid compounds, including kaempferol, myricetin and quercetin (Edwinanto et al., 2018). Meanwhile, phenolic compounds directly contribute to the antioxidant activity of Moringa leaf extract. Antioxidant activity is usually associated with the ability to scavenge free radicals and provide protection against oxidative damage to body cells (Sreelatha & Padma, 2009). Another study stated that the amino acid composition of dried Moringa leaves such as methionine and cysteine is a strong

antioxidant compound to neutralize exposure to radicals that are harmful to the body. Amino acid components also play an important role in the production of enzymes, hormones, immunoglobulins, repair body tissues and improve red blood cell structure (Moyo et al., 2011).

The benefits of Moringa leaf extract as an antimicrobial were studied by (Bukar, Uba, & Oyeyi, 2010) who stated that the antimicrobial activity of Moringa leaves can inhibit the growth of pathogenic bacteria including *Enterobacter spp*., *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Eschericia coli*. This is supported by another study which reported that the application of Moringa leaf acetone extract at a concentration of 5 mg/ml could inhibit the growth of *E. coli, Enterobacter cloace, Proteus vulgaris, S. aureus and Micrococcus kristinae* bacteria (Moyo et al., 2012).

Moringa cultivation technology

In Indonesia, Moringa plants grow in almost all areas and are most commonly found in Madura, Sulawesi, NTT, and Blora (Wasonowati, Sulistyaningsih, Indradewa, & Kurniasih, 2018). Moringa plants can grow quickly in one place even in drought conditions, but in waterlogged soil conditions, the roots will rot. In general, Moringa plants can grow well in tropical and sub-tropical climates, rainfall around 250-2000 mm per year, altitude between 0-2000 m above sea level, pH 5-9, sandy or sandy loam soil type, and if the rainfall is less than 800 mm, an irrigation channel is needed (Krisnadi, 2015).

Moringa plants are very easy to grow because they can be propagated either through vegetative (cutting) or generative (seeds). Planting by cuttings is a common thing that is often done because it tends to produce lush branches, unlike the case when planting with seeds which tends to produce tall plant stems with few branches (Krisnadi, 2015).

Several studies have been carried out to see the growth of Moringa plants, both by means of propagation and planting with several planting media, and applying fertilizer. Propagation of Moringa from stem cuttings using soil, husk charcoal, soil and cocopeat planting media gave a significant effect on the vegetative growth of Moringa seedlings when compared to soil mixed with sawdust, corn cobs, and bamboo leaf litter (Sawaludin, Nikmatullah, & Santoso, 2018). Another study (Rokhmah, Sugiartini, & Islamiah, 2020) stated that the application of a mixture of soil and compost planting media gave better results on vegetative growth (plant height, stem diameter, and number of shoots) of Moringa plants compared to soil, soil and vermicompost media, soil and cow manure, and rabbit soil and manure.

The research of Sowmen, Rusdimansyah, Zainab, & Santi, (2016) showed that statistically there was no significant difference for the growth and production of Moringa plants with the application of several doses of P fertilizer, namely SP36 and *rock phosphate* in the early vegetative period in ultisol soils. In other studies, the application of a fertilizer dose of 50 kg TSP/ha+50 kg urea/ha tends to give the best growth and yields on regosol soils compared to latosol and mediteran soils, although there is no interaction between soil type and fertilizer dose (Adhi, Kusumawati, & Witariadi, 2019).

Benefits in food sector

Application in meat products

Jayawardana et al. (2015) studied the antioxidant activity of chicken sausage with the addition of Moringa leaf extract. The spoilage of minced meat products, such as chicken sausage, is mainly caused by lipid oxidation and microbial growth which results in a short shelf life of the product. Fat oxidation in meat products can cause quality changes in terms of color, taste, texture and even nutritional value. The application of Moringa leaf extract reduced the value of *thiobarbituric acid-reacting substances* (TBARS), which was thought to be due to the polyphenol content of Moringa leaves. During storage, sausage pH with the addition of Moringa leaf extract decreased and was lower than the control which had an effect on increasing the shelf life of sausage product (Sallam, Ishioroshi, & Samejima, 2004).

Another study regarding the supplementation of Moringa leaf meal up to 5% of the daily diet of poultry affected the fatty acid composition of broiler meat. The TBARS value also decreased which is an indication that Moringa leaf flour supplementation was able to reduce lipid damage in broiler breast meat. Even on cold storage on 8 days and followed by frozen storage, the unsaturated fatty acid profile of meat was higher. Thus, considering the profile of unsaturated fatty acids and antioxidant stability in poultry meat supplemented with Moringa leaf flour, it is concluded that Moringa leaf flour is a promising source of antioxidants for broiler chicken meat (Nkukwana et al., 2014).

Application in dairy products

(a) *Butter oil*

Nadeem et al. (2013) have conducted a study on the potential of Moringa leaf extract as a stabilizer for *butter oil* related to the antioxidant activity of the extract. Fat was obtained from two groups of cows with feed supplements in the form of 300 grams of fatty acid calcium salt per day per head and the other group as a control. (Gonzalez, Duncan, Keefe, Sumner, & Herbein, 2003). The high antioxidant properties of Moringa leaf extract are considered as potential stabilizers for modified butter oil made from high concentrations of fatty acids. The addition of 800 ppm Moringa leaf extract caused

the conjugated diene value of *butter oil* to be lower than the control. The antioxidant properties of Moringa leaf extract have been shown to have a positive effect on the inhibition of conjugated diene formation in the product. In addition, the greater the value of conjugated triene in the control indicates that the level of oxidation in *butter oil* with the addition of Moringa leaf extract is lower than the control. Moringa leaf extract significantly reduces oxidation formation at all oxidation stages (Nadeem et al., 2013).

(b) Yogurt

Microbial analysis studies on probiotic yogurt enriched with Moringa leaf extract were carried out by adding the extract to yogurt during the cooling process to 37°C before inoculation of the starter into milk. The results showed an increase in the growth of probiotic bacteria which was also supported by the addition of sugar. Therefore, in the addition of high doses of Moringa leaf extract, no sugar was added. Sensory analysis showed that yogurt with the addition of 0.5% Moringa leaf extract with 5% sugar was acceptable. However, yogurt with the application of Moringa leaf extract without sugar can be accepted as a companion to certain foods with a good taste. In contrast, yogurt with the addition of 1% Moringa leaf extract caused a taste that was unacceptable to the panelists (Hekmat, Morgan, Soltani, & Gough, 2015).

Application on flour-based products

(a) Noodle

Kiranawati & Nurjanah (2014) conducted a study on the effect of Moringa leaf extract on lactagogum related to milk production of wistar rats. The treatment of feeding fortified noodles with Moringa leaf extract can increase the body weight of female rats reaching 0.25-0.37 grams/gram of feed. The addition of Moringa leaf extract can increase the productivity of the udder gland, which is indicated by an increase in the number of mammary gland alveoli in female rats with an average of 257.67 by the boiling process, 286 by the steaming process and 382.67 by the frying process. Moringa leaf extract has a laktagogum effect because it contains phytosterol compounds which are very important for enlargement and increasing the number of mammary glands so that it affects milk production. Another study found that adding 3% Moringa leaves to the noodles can increase the fiber content of food up to 4.1-4.14% with a shelf life of 180 days. In addition, this noodle can be classified as a low-glycemic food because of its low glycemic index of 47 (Ganga, Karthiayani, Vasanthi, & Baskaran, 2019).

(b) Cookies

The increase in the nutritional value of cookies is indicated by an increase in the content of minerals (calcium and iron) and protein. Protein content increased from 8.91 to 9.73; 10.38 and 9.77% for the addition of 5.10 and 15%, respectively, of Moringa leaf extract. The dietary fiber of the control sample was 1.16% increased to 2.63%, 2.70% and 3.11% for the addition of 5.10 and 15% Moringa leaf extract, respectively (Mouminah, 2015). Another study studied Moringa leaf cookies to improve concentration among teenagers. A total of 53 adolescents (13-15 years) were studied for observation of concentration ability, physical activity and level of anxiety by consuming cookies enriched with Moringa leaves (5 g, 10 g and control) for 14 days. The concentration ability of the subjects increased from 2.55 to 2.90 for the adolescent group treated with consumption of 5 g of Moringa leaf cookie and from 2.42 to 2.98 for the adolescent group treated with consumption of 10 g of Moringa leaf cookie. One of the polyphenolic elements present in Moringa leaves is chlorogenic acid which functions to reduce the activity of the acetylcholine esterase enzyme. The increase in synapses at the level of acetylcholine causes increased intercommunication of neurons so that the cholinergic function of the brain's memory system increases and affects the ability to concentrate (Adiputra, Santoso, & Wiboworini, 2020).

(c) *Cake*

Moringa leaf extract with different portions (0, 2, 4, 6, 8 and 10 g) was added to the cake made from wheat flour. Baking was carried out at 180°C for 30 minutes in an electric oven. The nutritional composition of cake increased in terms of water content, crude protein and total ash. Meanwhile, the fat and carbohydrate content decreased in line with the increase in the added content of Moringa leaf extract. cake has a negative effect on controlling the use of cake because it contains fiber (Kolawole, Mutiat, & Opaleke, 2013).

Economic potential of Moringa

Moringa as an abundant natural resource in Indonesia has the potential to improve the welfare of the community and the economy of a region. Most people only use Moringa leaves as a complement in daily cooking, not even a few who make Moringa leaves only as ornamental plants that are left attached to their yards, besides that in some areas in Indonesia the use of Moringa leaves is mostly used for bathing corpses, shed amulets, and as fodder. This happens because of the local community's lack of understanding about other types of products that can be produced from Moringa leaf raw materials. The lack of public awareness of technological developments and the slow access to information entering rural areas make people miss important information that has been and is being developed, including important information about simple appropriate technology that can be applied to everyday life. In

addition, the level of education also affects the mindset of people's lives so that new creations are difficult for them to create and develop. Lack of facilities and infrastructure, far from the city is also an obstacle in accepting the latest technology (Hasanah, Fitriana, Indriati, Masruroh, & Novia, 2019).

Moringa as a plantation commodity is not only marketed as a fresh commodity, but can be further processed as a processed product in agro-industry activities. In accordance with the Presidential Instruction No. 6 of 2009 concerning the Development of the Creative Economy. The plantation sector, especially the Moringa commodity, has sought the growth of creativity and the spirit of developing value-added and competitive productive businesses in farming communities, especially agribusiness actors. The target to be achieved is the growth and development of moringa-based creative economic activities according to local potential and wisdom. One of the natural resource management activities is the development of moringa commodities as part of the plantation sub-sector that can play an active role in improving the economy of rural areas, both in cultivation activities (on farm) and in agro-industrial activities (off farm). Utilization of these plant parts into various processed products of economic value through the development of agribusiness and agro-industry (Soetriono, Soejono, Zahrosa, & Maharani, 2019).

Moringa plant products can be used as business opportunities by creating added value in the field of herbal medicines and functional food culinary, such as Moringa tea. By inviting the community to manage Moringa gardens, the results of which can be sold or consumed by the community, so that they remain healthy, family income will increase, and the economy of the local community will increase, making the community more prosperous, especially in today's era where the cost of living is increasing sharply. 21st century agriculture for developing countries must be able to create agricultural systems that have high productivity but with low input costs. Businesses that have been running, for example, are the production of 12 g and 25 g moringa tea. The calculation results of processing Moringa leaves, with 40 stems of Moringa, can increase the income of at least Rp. 1 million/month (Suhaemi, Anwar, Sumarni, Irgantoro, & Yusniati, 2018); and attitude in independent business. Entrepreneurship and innovation are important in the creative process of the economy. Innovation is a specific function of entrepreneurship, as a way of creating new resources that utilize existing resources to produce riches. Training activities for the community in making Moringa Leaf Chicken Nuggets but also providing information about marketing strategies and of course production skills to sell. One of them is by processing Moringa leaves into processed food products with economic value that can directly improve people's lives.

The processing of various kinds of processed moringa products aims to provide added value, both economically and in volume so that it can provide benefits for entrepreneurs. Various kinds of Moringa leaf preparations are: Moringa powder, Moringa parasite powder, Moringa sticks, Moringa crackers and Moringa tea. The creation of added value of Moringa leaves into various preparations can provide benefits (Soetriono et al., 2019). The Moringa powder processing industry, Moringa crackers and Moringa parasite powder, the profit margin of the company or industry is greater than the income margin or employee benefits. In this case, Moringa powder entrepreneurs are more concerned with the profits of the company or industry than income or labor benefits. Processed Moringa leaves into Moringa sticks, the margin distributed to the workforce is 22.44 percent. The margin for the contribution of other inputs is 65.96 percent. Meanwhile, the profit margin for the company or industry is 11.60 percent, which is a reward for the company or industry for the use of capital, assets and management. From the distribution results of the profit margin of the company or industry, it can be concluded that the margin for income or employee benefits is greater than the profit margin of the company or industry. In this case, Moringa stick entrepreneurs are more concerned with income or labor rewards than the profits of the company or industry. Likewise with processed Moringa tea, from the distribution results of the profit margin of the company or industry, it can be concluded that the income margin or employee benefits is greater than the profit margin for the company or industry. In this case, Moringa tea entrepreneurs are more concerned with income or labor rewards than the profits of the company or industry.

Moringa's economic potential through increasing added value needs to be managed on a large scale in this case Moringa agroindustry, namely processing Moringa into processed products. Both in the form of an intermediate product (*intermediate product*) and the final product (*finish product*). This includes post-harvest handling, food and beverage processing industry. Agroindustry can have a broad economic impact not only on individuals but on the wider community and even an area or region. the role of agroindustry continues to be developed because it provides economic benefits, especially the agricultural product processing industry located in rural areas, namely based on existing resources and has functions including: (a) increasing rural employment, (b) increasing the value of added, (c) increase farmers' income, and (d) improve the quality of agricultural products, which in turn can meet the requirements to meet foreign markets

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