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Rosemary Recent Classification, Plant Characteristics, Economic Parts, Marketing, Uses, Chemical Composition, and Cultivation

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Abstract:

Aromatic and medicinal plants (AMP) have wide applications in traditional and modern food, medicine, and cosmetic systems. They have potential use for various health treatments, food/feed, and cosmetic industries. Rosemary is one of the important aromatic and medicinal plants recognized globally. Rosemary is known having different common name from one country to the country. It is perennial plant from the mint family with ever green leaves. Recently its binomial name change reported as Rosmarinus officinalis changed to Salvia rosmarinus. Rosemary product can be fresh or dry leaf as well as transformed into oils, extracts, and essences. Rosemary comprises different varieties that can be used for fresh herb, dry herb and for essential oil. Rosemary has economic, social and environmental benefits. Despite of the various constraints, production and marketing of rosemary showed increment from year to year. Therefore, this paper presented information concerning the historical common and binomial naming systems of rosemary, botanical narrative, its origin and distribution, important plant parts and their benefits, chemical constituents, global demand, and cultivation practices for users.

Key words**:Chemical composition, Essential oil, Rosemary**

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I. INTRODUCTION

1.1 Recent Classification and the Trends of Using the New Binomial /Scientific/ Name

Rosemary is one of the versatile aromatic plants from the Lamiaceae family. It is popular herb in many countries for its leaf and essential oil yield. Rosemary has various common names like asmerino in Ethiopia, romero in Spain, rosmaninho in Portugal, mehendi in India, rosmarin in German, romarin in French, and mi die xiang in China. Despite different names given to rosemary from different countries in the world, the plant was known by one scientific name (Binomial name). The use of binomial system was initiated during 1700s by Swedish naturalist Carl Linnaeus and the binomial name of rosemary herb was *rosmarinus*

officinalis so far. The name *rosmarinus officinalis* was used among growers, academic and research institutes and scientists all over the globe used the name regardless of the various common names of the popular rosemary herb. The genus name, *Rosmarinus*, comes from the Latin words *ros* (dew) and *marinus* (sea) which born a name called dew of the sea, in probable reference to the ability of this plant to thrive well in coastal areas (sea cliffs) and exposure to ocean mists. Various common names for rosemary herb could be due to variation of languages from place to place. In the contrary, binomial name of a living thing remain constant unless renamed based on new findings which was done for rosemary herb recently. Based on DNA analysis the common genus name of rosemary since 18 century becomes the species name of the herb so that the name *Rosmarinus officinalis* has become a synonym of the actual name *Salvia rosmarinus* (*Rosmarinus officinalis* changed to *Salvia rosmarinus*) (Drew *et al*., 2017).

1.2 Rosemary Origin and Distribution

Rosemary with diverse genetic diversity was believed to be originated from the western Mediterranean basin (Mateu-Andrés *et al.,* 2013) and has been cultivated since ancient times as landscape plant as well as pot crop for ornamental purposes, leaves and essential oil products (Simon *et al.,* 1984). In their demographic expansion study (Mateu-Andrés *et al.,* 2013) indicated different routes of rosemary migration such as a northern route expanding along the northern side of the Mediterranean, two southern routes, one from west to east through North Africa and reaching Cyrenaica, and a second to the south-west of the Iberian Peninsula, from where it came back to the south–central areas.

1.3 Botanical Description

Rosemary plant is a woody aromatic perennial shrub with fragrant evergreen needle-like leaves. It belongs to the mint family, Lamiaceae. It grows upward (erect) and can extent up to a height of 2 m. The leaves are evergreen, 2-4 cm long and 2-5 mm broad, green above, and white below with dense short woolly hairs. Different rosemary varieties have different leaf sizes, branch growth habit, and flower color (white, pink, purple, or blue) (Mateu-Andrés *et al*., 2013: Zigene*et al*., 2023). Botanical variation in rosemary plant varieties resulted in the variation of rosemary herbal, oil yield, and chemical compounds (Banjaw *et al*., 2016; Abdo *et al*., 2018).

1.4 Rosemary Economic /Beneficial/ Parts, Marketing and Uses

1.4.1 Economic /Beneficial/ Plant Parts

The economic parts of rosemary plant are leaves (fresh and dry), flower twigs, and the essential oil obtained from herbal products (Afshar*et al*., 2022). Hence, cultivation and wild harvesting of rosemary is manly for its needle-like leaves that can be

utilized in the form of either solid or liquid through different value addition practices.

1.4.2 Rosemary Marketing .

Global demand for fresh and dry leaves of rosemary has increasing trend in both price and quantity (Industry ARC, 2023). Besides, global demands for rosemary essential oil have increasing trend. Population growth, growing knowledge of the advantages of rosemary products,rising popularity of organic foods and substances, increase in health problems, increased consumers interest for organic natural products, and growth in industries thought to be the major reasons behind the increment of rosemary products (Kaur *et al,* 2021; Tzima*et al.,* 2015). Due to the high demand for it as a food additive and a food/drink ingredient, the rosemary extracts market was estimated at USD 215 million in 2019 and is anticipated to grow at an annual rate of 3.7 percent between 2020 and 2025.

1.4.3 Rosemary Uses

Rosemary widely used in various industries. In food industry, rosemary used for flavoring (Turan and Yiğitarslan, 2016), preservative (Nieto *et al.,* 2010; Jiang *et al*., 2011; Santoyo*et al*., 2005), and for food additive (Turan and Yiğitarslan, 2016). Addition of aqueous extract of rosemary positively affected the sensory properties of yoghurt (flavour, body and texture, appearance, and overall grade) (Ali *et al.,* 2021). On the other hand, 25% treatment of rosemary extract with fed has positive effect on growth in African catfish with no apparent effects on health status (Turan and Yiğitarslan, 2016). In Ethiopia, fresh rosemary leaves known by the name Asmerino and/or YetibseKetel which is to mean seasoning meat and used for food flavoring at many restaurants and hotels. Besides, dried rosemary leaves added to traditional spiced food materials preparations (Mekonnen and Manahile, 2017).

Rosemary essential oil has wide application as row material for various industries like pesticide, pharmaceuticals, and cosmetic and also for folk medicine (Zigene*et al.,* 2012; Waithaka*et al*., 2017). Rosemary extracts have preservative benefits and pesticide properties. According to Waithaka*et al*. (2017), rosemary essential oil extract was effective in controlling maize fungal disease. The importance of rosemary essential oil as fumigant against bruchid under the storage conditions was reported (Hannour*et al*., 2018). The potential of rosemary fresh leaves and branches to improve potato storage life because of its simplicity and efficacy in decreasing storage cost, the weight loss and sprouting without causing any environmental toxicity was reported (Talei*et al*., 2017). On the other hand, rosemary essential oil components have antimicrobial activity (antibacterial, antiviral and antifungal properties) (Jiang *et al*., 2011; Pintore*et al*., 2002; Santoyo*et al*., 2005). Rosemary has many medicinal applications such as treatment of disorders associated with the nervous,

cardiovascular, gastrointestinal, genitourinary, menstrual, hepatic, and reproductive systems and with respiratory and skin conditions (Begum *et al*., 2013).

Moreover, in addition to its industrial and cultural uses, rosemary has social and environmental benefits. Rosemary nursery and production was being seen as business because of the employment opportunities. Besides, there was scientifically proved environmental benefits of rosemary cultivation (Zuazo*et al*., 2008). The authors reported that, integration of rosemary plant strips on farmland improves the existing systems, by fomenting complex biological interactions and controlling erosion. Thus, rosemary in hilly areas provides an effective system for trapping agricultural runoff as well as reducing soil erosion, thereby avoiding the soil degradation. It was also indicated that yield penalty due to rosemary incorporation to the farmland can be overcome from rosemary either leaf or essential oil yield (Zuazo*et al*., 2008).

1.5 Chemical Composition

Many scholars reported the chemical composition of rosemary essential oil. Chemical composition study in Greece showed as the major constituents were α-pinene (24.1%), camphor (14.9%), 1,8-cineole (9.3%), camphene (8.9%), α-terpineol (8.8%) and borneol (8.0%) (Pitarokili*et al.,* 2018). Whereas study in China revealed as 1,8-Cineole (26.54%), α-Pinene (20.14%), Camphor (12.88%), Camphene (11.38%) and β-Pinene (6.95%) were the major constituents (Jiang *et al*., 2011). In Italy, α-pinene and 1,8-cineole identified as the major constituents (Filamini, *et al*., 2002). In Brazil, α-pinene followed by camphene reported as the major constituents of rosemary (Takayama*et al*., 2016). Moreover, in Spain, Santoyo*et al*. (2005) reported α-Pinene, 1,8-cineole and camphor as the main compositional constituents of rosemary. In Ethiopia, similar compounds were identified as major components of rosemary essential oil (1, 8-cineole, verbenone, camphor, α-terpineol, isoborneol, tridecyl acrylate, linalool, bornyl acetate, *trans*-caryophyllene, terpine-4-ol, and α-pinene (Asressu and Tesema, 2014). In their chemical characterization study of rosemary essential oil, Kassahun and Feleke (2019) also reported that α -pinene (50.8 %), 1, 8-cineole (24.4 %), camphene (5.2 %), camphor (3.8 %), caryophyllene (2.9 %) and β-pinene (2.1 %) were the major chemical composition of rosemary oil in Ethiopia.

1.6 Rosemary Production

Rosemary cultivation and handling have essential steps. These comprise seedling preparation, land preparation, transplanting, field management, harvesting, processing, packaging, transportation, and storage.

1.6.1 Rosemary Propagation

Rosemary can be propagated by seeds or by using vegetative parts like layering and cutting. Rosemary seeds have problem of viability as well as problem of getting true-to type material and needs further improvement investigations (Plant production directorate, 2012). However, top part 10-15cm rosemary cuttings used for seedling preparation from disease free mother plant not more than one year old. The bottom two thirds of the cuttings are stripped from leaves and inserted in a proper growing medium. The cuttings can be prepared in green house and transplanted to the main field after 60-90 days. Rooting hormones will assist in root formation within 2 to 4 weeks. Rosemary stems with flowering, old woody and very young plants are not advised for cutting preparation (Mekonnen *et al.,* 2016). Moreover, mass propagation by tissue culture technology is also alternative means of rosemary propagation.

Figure1.Rosemary seedlings ready for transplanting, Wondo Genet Ethiopia.

1.6.2 Land Preparation, Transplanting, and Field Management

Land for rosemary production should be free from weeds, shades, and should be ploughed two to three times to make the soil favorable for the seedlings. Rosemary grows well in areas that has an average temperature ranges from 20 to 25oc, receive above 500 mm average annual rainfall and performs well within an altitude range from 1500 up to 3000 meters above sea level (German *et al*., 2016). Rosemary grows well in sandy loam soil while soil with high clay content as well as water lodged area is not suitable (Gharib*et al*., 2016). Rosemary tolerates heat, drought, and poor dry soil with pH ranging from acidic to alkaline, prefers well drained soil (PFAF, 2014). Soil acidity is a condition in which the soil pH is lower than a neutral pH (less than 7). The main causes of the soil acidity include high rainfall and leaching, acidic parent material, organic matter decay, and harvest of high yielding crops. The acid tolerance of rosemary is a good opportunity for areas affected by soil acidity. Soil acidity is among the major land degradation problems, which affects about 50% of the world's potentially arable soils (Kochian*et al*., 2004). In Ethiopia soil acidity is one of the constrained for crop production and productivity. About 43% cultivated land of Ethiopia affected by sol acidity among which 28% is strong acidic soil (ATA, 2014; Haile *et al*., 2017). For instance, highland areas of Sodo, Hosanna, Endibir, Nedjo, Chencha, Hageremariam, Nedjo and Gimbi and Awi areas are

severely affected by soil acidity problem in Ethiopia (Sertsu and Ali, 1983).

Rosemary plant spacing varies depending on variety, production purpose, and management practices. Nibret Tadesse (2019) reported spacing combination of 50 cm intra-row x 60 cm inter-row responded favorably in attaining higher rosemary leaf yield and essential oil yield under field condition in mono-cropping. Rosemary can be cultivated either by mono cropping or multiple cropping system as it is compatible with many crops. Nigussie *et al.* (2020) reported the yield and competitive advantage of intercropping rosemary with carrot. Besides, inclusion of onion with 80% a rosemary population density elevated yield advantage and competitiveness over sole planted crop per unit area as indicated by higher land equivalent ratio and relative crowding coefficient (Adafre*et al*., 2019). Rosemary cultivation is becoming advantageous because of the low production cost and comparable returns. The low production cost linked to the perennial nature of the plant and the low input demand during cultivation.

Rosemary seldom needs fertilizer, however, if rosemary plant growth is slow or the plant appears stunted, application of any all-purpose fertilizer in dry or liquid form once immediately after harvest recommended. A fertilizer experiment indicated that combined application of vermicompost 10 t ha^{-1} + fertilizer NPK (100:25:25 kg ha^{-1}) significantly increased the herbage and oil yield of rosemary (Singh et al., 2013). In their study which consists combinations of N levels (0, 150, and 300 kg per hectare per year) and K levels (0, 50, and 100 kg per hectare per year), Puttanna*et al*. (2010) recommended application of 150 kg N and 100 kg K.Too much water can cause root rot. On average, water rosemary every 1 to 2 weeks, depending on the plant size and climate conditions. Rosemary plants need dry period between each watering. Although rosemary resists most diseases, some cases of soil born disease such as fusarium wilt have been reported (Mekonnen and Manahile, 2017). They reported that rosemary wilt caused by *Fusariumoxysporum*could lead to leaf and essential oil yield losses so that designing an integrated Fusarium wilt management method as alternative control measure for this disease is necessary.

1.6.3 Rosemary Harvesting and Drying

Proper harvesting stage, harvesting time, harvesting season, drying method and packaging material play great role in quality and quantity of rosemary herbal, essential oil and composition (KhademiDoozakhdarreh*et al.,* 2022; Sing *et al*., 2013). Purpose of the production and harvesting, as well as type of the rosemary variety determine the harvesting stage and harvesting time. According to Singh *et al*. (2013) seed setting stage produced maximum plant weight, herbage and oil yield of

rosemary compared with other stages of harvesting. Zigene*et al.* (2012) reported that harvesting rosemary for leaf yield and for essential oil yield at 9 months and at 10 months after transplanting were advantageous. However, rosemary harvesting for fresh leaf marketing could consider the interest of the buyer. According to Afshar*et al*. (2022), the best harvest season to get the most essential oil yield of rosemary is summer and autumn, which reached its maximum in mid-autumn significantly. Similarly Salido*et al.* (2003) reported that the highest oil yields were recorded during summer in rosemary. In another study, rosemary harvesting during spring season also recommended for essential oil yield and leaf biomass (Ismaili*et al.,*2017). Hence, seasonal changes should be considered when harvesting rosemary plants in order to separate antioxidant ingredients, phenolic compounds, flavonoids and important medicinal and industrial compounds. Advantages of shade drying reported (KhademiDoozakhdarreh*et al.,* 2022) as less essential oil evaporated from the plant compared to sun drying although it increased the drying time due to lower temperature.

1.7 Summary

Rosemary is one of the evergreen aromatic and medicinal plants from the Lamiaceae family. *Rosmarinus officinalis* currently called by the name *Salvia rosmarinus* has different common name in various languages. Rosemary produced for its fresh or dry leaf, essential oil, and extracts which have been used in food, cosmetics, and pharmaceutical industries. The potential of rosemary in various industries and traditional uses derived from the chemical constituents` antimicrobial activities. Global production and marketing of rosemary showed incremental trend. The growing knowledge of the advantages of rosemary products,rising popularity of organic foods and substances, increased consumers interest for organic natural products and growth in industries thought to be the major reasons behind the increment of rosemary industry.

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