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RESIN PRODUCTION IN TÜRKİYE: HISTORICAL DEVELOPMENT, PRODUCTION TECHNIQUES, AND INDUSTRIAL APPLICATIONS

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ABSTRACT

This study presents an overview of the historical development of natural pine resin production in Türkiye, focusing on production techniques, commonly used species, the current production status, challenges in the sector, and major application areas. Natural resin is an important non-wood forest product with considerable economic and industrial value, both globally and in Türkiye. Resin production has its roots in ancient times, when traditional methods were first developed. Over the centuries, various improvements and innovations have transformed these practices into the modern production techniques used today. This transformation period in the resin production has shown a similar development from the Ottoman Empire to present-day Türkiye. Today, resin production in Türkiye is carried out primarily using the bark streak method – the most widely preferred approach – while the borehole method is employed to a lesser extent. Pine resin is mainly obtained from two species: Turkish pine (*Pinus brutia* Ten.) and maritime pine (*Pinus pinaster* Ait.). Türkiye possesses substantial potential for resin production, and in recent years, various studies have been undertaken to enhance existing capacity. It is anticipated that future research, building upon the information presented in this study, will support the more effective utilisation of Türkiye's resin resources and guide subsequent scientific and industrial developments.

Keywords: resin, production methods, Türkiye, Turkish pine, maritime pine

INTRODUCTION

Türkiye possesses rich ecological diversity, with 78 million hectares of land area, and forests represent an important part of this natural wealth. According to 2020 data from the General Directorate of Forestry, 29.4% of Türkiye's total area is covered by forests. Coniferous forests, including Turkish pine, black pine, Scots pine, fir, spruce, and cedar, constitute 48% of this area; broadleaf forests, including oak, beech, alder, chestnut, and hornbeam, constitute 32%. Mixed forests, comprising both coniferous and broadleaf species, constitute the remaining 20% of the forested land. Oak, with 6.7 million hectares, has the largest distribution area in Türkiye's forested land, followed by Turkish pine (GDF, 2020).

In forest resource management, the production of non-wood forest products has gained increasing importance alongside timber production. Considerable efforts have been made to conduct inventories, develop management plans, implement sustainable operations, and establish market systems for non-wood forest products of both plant and animal origin (DSB, 2019). These products include all types of plant- and animal-based materials originating in or around forest

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Table 1. The amount of resin production (tons) in Türkiye (GDF, 2025)
Tabela 1. Ilość produkowanej żywicy (tony) w Turcji (GDF, 2025)

Performance indicator	Unit of measurement	2023	2024		2025 target	2026 estimated	2027 estimated
			planned	realized			
Resin production amount	Ton	3.583	3.449	4.546	4.233	4.903	4.903

areas that are used by humans and other living organisms to meet their needs or generate income (Kurt et al., 2016). Non-wood forest products also encompass ecosystem services such as recreation, ecotourism, and biodiversity conservation, as well as non-woody silvichemical products like resins, tannins, and essential oils derived from industrial wood processing. Among these substances, resin products hold the largest share in terms of both volume and economic value (Deniz, 2018; Deniz et al., 2014).

Raw resin is obtained from living pine trees. It is sticky, viscous, and generally remains in liquid form when collected. However, it is opaque – due to trapped moisture – milky grey in colour, often containing small amounts of forest debris such as pine needles or insects. Rosin, the main product derived from pine resin, remains as a non-volatile residue after the distillation of turpentine. It is a transparent, brittle, and glassy solid (Coppen and Hone, 1995). Resin is a chemical compound that the tree does not reuse once secreted and plays an important role in its defence mechanisms (Angın and Ertaş, 2021; Kolosova and Bohlmann, 2012). Pine resin is one of the most important non-wood forest products, used worldwide since ancient times and still widely utilised today. Production of this biological material has increased in recent years, and this upward trend is expected to continue.

Although Türkiye has significant potential for resin production due to its extensive pine forests and favourable ecological conditions, this potential has not yet been fully utilised commercially. As in other resin-producing countries, resin represents a key economic and strategic non-wood forest product. The wide distribution of Turkish pine forests and the suitability of their growing conditions indicate that resin production capacity could be further increased. The rise in resin production in recent years supports this positive outlook, as shown by data provided by the General Directorate of Forestry (GDF) (Table 1).

According to the data in Table 1, resin production has shown an upward trend since 2023. In particular, the 2024 data indicate that actual production reached 4,546 tons, exceeding the planned amount of 3,449 tons – demonstrating a positive development in the resin sector. The production targets set by the General Directorate of Forestry for 2025 and 2027 reflect a strategic focus on further expanding production capacity.

This paper aims to provide a general assessment of the historical development, current status, production techniques, and applications of resin production in Türkiye. Resin production activities are primarily carried out by the General Directorate of Forestry (GDF). Although some private enterprises have recently become involved in the sector, commercial-scale production has not yet become widespread. Research on resin production in Türkiye has remained limited due to various conditions over time. Therefore, the sources used in this study primarily include data and action plans published by the GDF, as well as national development plans, research institute projects, technical reports, field applications, and various academic publications.

TREE SPECIES USED IN RESIN PRODUCTION IN TÜRKiYE

Türkiye's forests have significant potential for resin production due to the abundance of pine species such as Turkish pine, black pine, yellow pine, stone pine, and maritime pine. Among these species, black pine has the highest density of resin canals; however, it is not suitable for commercial resin production because it primarily grows in high-altitude, cool areas far from the sea. Although the distribution range of stone pine is favourable for resin extraction, the species is mainly cultivated for pine nut production, as resin tapping reduces seed yield in its cones. Yellow pine is also not

preferred because it typically occurs in mountainous regions that are difficult to access (GDF, 2017). While small-scale resin production from these pine species was carried out in the past, today they are used mostly for research purposes.

Considering ecological conditions and resin yield potential, the two most commonly used species for raw resin production in Türkiye are *Pinus brutia* Ten. (Turkish pine) and *Pinus pinaster* Ait. (maritime pine) (GDF, 2017). Forest areas suitable for resin production are mainly located in the Mediterranean, Aegean, and Marmara regions (Karademir, 2023). The characteristics of these two principal species currently used in resin production are explained below.

Turkish pine (*Pinus brutia* Ten.)

Turkish pine is the pine species with the widest distribution area in Türkiye, accounting for 22.74% of the general forest area (GDF, 2020). It typically grows 15–25 m tall and is characterised by deeply fissured, reddish-brown bark. In Türkiye, the species occurs at altitudes up to approximately 1,500 m in the Mediterranean Region, 900 m in the Marmara Region, and 600 m in the Black Sea Region (Akkemik, 2020). According to the Resin Action Plan (2017–2021) prepared by the General Directorate of Forestry of Türkiye, the resin yield obtained from the trunk of Turkish pine is 7.32%, giving this species the highest potential for resin production (GDF, 2017). Figure 1 shows the distribution of Turkish pine in Türkiye (GDF, 2013). *Pinus brutia* Ten. forests are considered the most suitable for pine resin production through tapping, owing to the favourable climatic conditions and topographical features of their natural range (Satil et al., 2011).

Maritime pine (*Pinus pinaster* Ait.)

Maritime pine is a fast-growing pine species with a thick bark and a smooth trunk that can reach heights of up to 35–40 m. It grows naturally along the coasts of France, Italy, Monaco, Malta, Algeria, Morocco, Tunisia, Spain, and Portugal. Although not native to Türkiye, it has been introduced in some coastal areas and is also found in parks and gardens (Akkemik, 2020). Maritime pine accounts for 0.24% of Türkiye's total forest area (GDF, 2020). According to the resin action plan (2017–2021) prepared by the General Directorate of Forestry of Türkiye, this species has been found suitable for raw resin production, particularly in trial plantations established in afforestation areas since 2013 (GDF, 2017).

RESIN PRODUCTION IN TÜRKiYE FROM PAST TO PRESENT

During the Ottoman Period and earlier, pine resin was collected by making angled cuts in pine trees and allowing the resin to flow out. The resin obtained in this way was then collected and used in its natural form. After the Ottoman Empire, significant changes occurred in resin production practices in Türkiye over

Fig. 1. Distribution areas of Turkish pine in Türkiye (GDF, 2013)
Ryc. 1. Obszary występowania sosny tureckiej w Turcji (GDF, 2013)

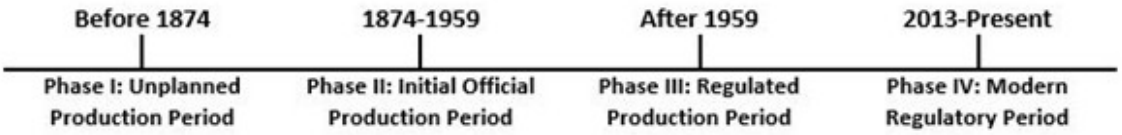

Fig. 2. The timeline of resin production in Türkiye
Ryc. 2. Oś czasu produkcji żywicy w Turcji

time, and various methods were tried. The timeline of resin production in Türkiye is shown in Fig. 2.

The evolution of resin production shows a shift from early, small-scale, traditional methods to increasingly integrated and industrialised systems:

Phase I: Before 1874 (Unplanned Production Period): This first period was characterised by unplanned production without any regulation of resin extraction.

Phase II: 1874–1959 (Initial Official Production Period): This was the period between when the first official resin production took place in Türkiye. Pine resin production was initiated in state forests based on the principles specified in the nine-article resin production regulation.

Phase III: After 1959 (Regulated Production Period): The Mazek Line Method was officially accepted as the standard technique for resin production in Türkiye. After 1985, the acid-paste method was introduced, marking a significant change in resin extraction practices and production processes.

Phase IV: 2013–present (Modern Regulatory Period): In 2013, the General Directorate of Forestry of Türkiye released the Regulation on the Inventory, Planning, Production, and Sale of Non-Wood Forest Products (GDF, 2017). In this regulation, the production and sale of pine resin were established according to the acid-paste method currently in use. This period marked the beginning of a new era for Türkiye's resin industry.

Studies on resin production using the acid-paste open wound method were first carried out by Prof. Dr. Savni Huş between 1947 and 1948 for experimental purposes. Since then, resin production has continued with different stimulants and method applications, and various studies have been conducted to improve these methods over time (Acar et al., 1996; Berkel and Huş, 1956; Deniz, 1987; Deniz et al., 2014; Gürsü, 1966; Önal, 1995).

The Mazek Line Method, one of the various wounding techniques, began to be applied in Türkiye in the 1950s. During this period, chemicals such as hydrochloric acid and sulfuric acid were tested as stimulants, but these applications were not widely used, particularly in resin production studies carried out by the State Forest Enterprises in Turkish pine forests. Globally, various risks associated with applying liquid sulfuric acid as a stimulant led to the development of acid-paste formulations in the 1970s. In the 1980s, resin production began to be outsourced to the private sector in Türkiye, and a private company initiated trials of the acid-paste method in some production sites. The technique gradually replaced traditional wounding methods and became widely adopted, leading to the abandonment of older practices (Acar et al.,1996).

RESIN PRODUCTION IN TÜRKiYE

Pine resin production in Türkiye is strongly influenced by seasonal climatic conditions of the region where the resin is produced. Resin production typically begins in spring (April-May), when rising temperatures stimulate resin secretion. During summer (June-August), yields reach their peak, coinciding with the warmest period of the year; harvesting is generally conducted at 15-day intervals. In autumn (September-October), as temperatures decline, resin flow gradually diminishes. Production halts over winter (November-March), when low temperature conditions inhibit resin exudation (Deniz, 2018).

Methods of resin production

Resin production methods have their origins in traditional wounding techniques, which gradually evolved – through the development of new applications – into semi-modern methods, and eventually into modern, industrial-scale processes. These advances have diversified resin production practices up to the present day.

Fig. 3. Traditional pine resin production stages in sequence (Satil et al., 2011)
Ryc. 3. Tradycyjne etapy produkcji żywicy sosnowej w kolejności (Satil i in., 2011)

Resin is obtained through three main methods: 1. Gum naval stores (by wounding the trunks of living pine trees), 2. Wood naval stores (by extracting from resinous stumps), 3. Sulphate naval Stores (obtained as a by-product during the kraft pulping process of resinous wood chips). Only the first two methods are currently economically viable in Türkiye; the sulphate method has not yet been adopted commercially (Aydın, 2017; Coppen and Hone, 1995).

Traditional pine resin production, practiced by various civilizations since antiquity, is no longer used in large-scale commercial operations. However, it remains an important small-scale activity in some rural areas of Türkiye. This traditional method is still applied by villagers, particularly around the villages around Kazdağı in Western Anatolia, where it continues to contribute to the rural subsistence economy. Figure 3 illustrates the main stages of traditional pine resin production as practiced by local communities (Satil et. al, 2011).

As shown in Figure 3, the process begins with making V-shaped incisions in the trunks of *Pinus brutia* (Turkish pine) trees. The resin that flows from these cuts, known locally as *sorkuç*, is typically collected between May and September. The collected resin is boiled over a wood fire, then shaped by hand before being filtered, cooled, and hardened in cold water. The resulting products are used by the villagers or sold – often by women – in local markets. In addition to its economic value, the resin continues to be used traditionally in these villages as a natural remedy for stomach and intestinal disorders when mixed with honey. This method reflects the accumulation of traditional ecological knowledge and provides a supplementary source of economic income for rural households (Satil et al., 2011).

Another important traditional technique is the bark streak tapping method, a long-established practice that has evolved into modern resin production methods with the introduction of acid-paste applications.

In contemporary resin production in Türkiye, the bark streak method and the borehole method are the most economically viable techniques, both of which are also widely used globally.

Bark streak tapping method

The bark streak tapping method is a commonly used resin extraction technique that can be applied in two forms: with or without a stimulant. The version of the method that uses an acid stimulant is also referred to as the acid-paste method. In this method, the outer bark of the tree is carefully removed, and the surface is smoothed to expose a reddish layer, preparing the tree for tapping. Using a conventional window-cutting tool, resin windows measuring approximately 15–17 cm in width and 3–5 cm in height are made. When acid application is used, an acid-based stimulating paste is applied to the exposed surface to induce and sustain resin flow. This treatment accelerates resin secretion and allows continuous resin flow over an extended period. The exuded resin is collected in specially designed containers, typically UV-resistant and leakproof plastic bags, to ensure efficiency and preservation during collection (Deniz et al., 2014; Deniz, 2018; GDF, 2017). The tools and materials used in resin production through the acid-paste method are presented in Figure 4.

Figure 5 illustrates the five main steps of the acid-paste method currently used in resin production (Deniz, 2018).

Stimulation Area Preparation: The bark of the tree is peeled upward and downward using a bark peeling and smoothing tool. This process exposes the cambial zone and prepares the "reddened area" (A and A') to ensure resin flow.

Guideline Cut: A guideline cut is made on the pine tree to initiate resin flow. A thin horizontal cut, approximately 10 mm wide and 10–15 cm long, depending on the tree's diameter, is made about 20 cm above the ground (B and B').

Wound Creation: In the designated area on the trunk, the wounding tool blade is aligned with the guideline (C), and the bark is removed from right to left (C'). This creates a wound area approximately 10–15 cm long without damaging the xylem tissue of the tree (C'').

Attachment of the Collection Bag: The plastic collection bag used for resin collection is unfolded

Fig. 4. (1) Bark peeling and smoothing tool; (2) groove-cutting tool for resin flow; (3) resin flow gutter; (4) plastic bottle; (5) plastic collection bag; (6) stapler (used for attaching the bag to the tree surface or resin collection system) (Deniz, 2018)
Ryc. 4. (1) Narzędzie do zdejmowania i wygładzania kory; (2) Narzędzie do nacinania rowków dla przepływu żywicy; (3) Rynna do zbierania żywicy; (4) Butelka plastikowa; (5) Plastikowa torba zbierająca; (6) Zszywacz (używany do przymocowania torby do powierzchni drzewa lub systemu zbierania żywicy) (Deniz, 2018)

Fig. 5. Application steps of the acid-paste method in resin production (Deniz, 2018)
Ryc. 5. Etapy stosowania metody pasty kwasowej w produkcji żywicy (Deniz, 2018)

from the top (D), then stapled to the bottom of the opened wound (D') and along both side edges to ensure it is secure and protected (D'').

Application of the Acid-Paste Stimulant: To stimulate resin flow, the prepared acid paste is applied to the wound area, starting from the right side (E). The paste applicator is moved steadily towards the left to ensure even application (E' and E'').

After completing these five main steps of the acid-paste method, pine resin is obtained (Deniz, 2018).

Borehole method

The borehole (BH) method involves mechanically drilling holes into the tree trunk, whereas the bark streak (BS) method entails manually creating incisions or streaks along the bark surface. In the borehole method, multiple holes are drilled from the base of the tree into the woody tissue, and the exuded resin is collected in a sealed container. The holes typically range from 2.5-3.8 cm up to 5.0 cm in diameter, with depths of 7.6–17.8 cm, and are positioned less than 10 cm above ground level. In recent years, although the borehole tapping method has been recognised for producing

Fig. 6. Methods of resin extraction: A: borehole, B: acid-paste method (Caglayan et al., 2025)
Ryc. 6. Metody pozyskiwania żywicy: A: odwiert, B: metoda pasty kwasowej (Caglayan i in., 2025)

high-quality resin, its relatively low yield has limited its widespread use (Deniz, 2018). As a result, resin production in Türkiye has predominantly continued using the acid-paste (bark streak tapping) method, which remains the standard technique for extracting resin from pine species across the country. A visual comparison of both methods is provided in Figure 6.

The two primary resin tapping methods described above (bark streak and borehole) are briefly summarised in Table 2 below (Deniz, 2018; Caglayan et al., 2025).

APPLICATION OF THE PRODUCTS

Pine resin consists of two main fractions: turpentine, the volatile component, and rosin, the solid component. Oleoresin, a key element in a tree's defence mechanism, is an important non-wood forest product due to the diverse conventional and potential uses of its terpene compounds. Oleoresin derivatives have a wide range of applications across the food, pharmaceutical, and cosmetic industries, as well as in the manufacture

Table 2. Comparative overview of resin production methods in Türkiye
Tabela 2. Porównawcze zestawienie metod produkcji żywicy w Turcji

Step	Bark streak (BS) method	Bore hole (BH) method
Preparation of tree	Certain parts of the tree's bark are peeled and the cambium layer is exposed	The bark around the drilling area is peeled to expose the cambium layer
Application technique	Vertical streaks are opened on the cambium of the tree	A hole is drilled at the specified height and angle
Application of acid	Prepared acid is applied to the upper part of the streaks	Acid is applied into the drilled hole
Collection of resin	Plastic bags are used to collect the resin by fixing them on streaks	The plastic tube is placed in the drilled hole; the resin is transferred to the fixed plastic bag
Transfer of resin	The resin accumulated in the plastic bags is transferred into barrels	The accumulated resin is transferred from the plastic bag to the barrel

of varnishes, paints, adhesives, disinfectants, and insecticides (da Silva Rodrigues-Corrêa et al., 2013).

In industrial processing, pine resin is subjected to steam distillation, which separates it into pine rosin (diterpenes) and pine turpentine (volatile components). These two resin fractions are used in the production of a variety of products in multiple sectors, including adhesives, coatings, printing inks, food additives, pharmaceuticals, perfumery, disinfectants, and cleaning products (Tümen and Reunanen, 2010). Natural resin (oleoresin) is rich in terpenes, giving it a wide variety of applications, particularly in the pharmaceutical and chemical industries (Caglayan et al., 2024). The non-volatile fraction, rosin, consists mainly of abietic and pimaric-type resin acids, which feature characteristic hydrophenanthrene ring structures. These confer excellent film-forming properties, making rosin valuable in numerous industrial applications. It is widely used in the paper industry (Neis et al., 2019; Yadav et al., 2016) and valued for its bioactivity. In addition, rosin exhibits good emulsifying properties, providing homogeneity and spreadability in cosmetic creams (Jangdey et al., 2024).

Turpentine, the volatile fraction of resin, also plays a significant role in various industries. It is widely used as a solvent for paints and varnishes (Coppen and Hone, 1995). Turpentine is rich in monoterpenes, which have diverse industrial applications. Borneol, for example, is used in cosmetics and in non-cosmetic products such as household cleaners. Monoterpenes such as myrcene, carveol, α-pinene, β-pinene, linalool, phellandrene, and terpineol are used as odorants in the food, perfume, and cosmetics industries, and as flavouring agents in food (da Silva Rodrigues-Corrêa et al., 2013). Additionally, turpentine is used in oil paint and varnish production, as well as in furniture and floor polishes. It also serves as an antiseptic for medical purposes and as an ingredient in insecticides. Moreover, turpentine is an important raw material in the preparation of synthetic camphor and in the synthesis of camphor and menthol (Deniz, 2018).

A BRIEF EVOLUTION OF RESIN PRODUCTION IN TÜRKiYE: OPPORTUNITIES AND CHALLENGES

While Türkiye possesses significant potential for natural resin production, it also faces various challenges in effectively realising this potential. In a study conducted by Caglayan (2025), a SWOT (Analysis of Strengths, Weaknesses, Opportunities, and Threats) analysis of factors affecting resin production from Turkish pine forests was carried out, leading to the following summary conclusions: Türkiye has substantial potential for natural resin production due to its extensive Mediterranean pine forest resources. Production practices such as the bark streak tapping method, which require relatively low technological input and have low initial costs, are easier to implement in rural areas and, when combined with the traditional knowledge of local residents, provide strong support for resin production. The wide range of uses for resin in industries such as chemicals, pharmaceuticals, and cosmetics also creates significant economic opportunities. However, several weaknesses have been identified. These include the lack of quality standards in production, high labour costs, and concerns about the sustainability and health of trees used for tapping. Additionally, the inability of current market prices to cover production costs poses a challenge to long-term economic sustainability. At the same time, increasing global demand for natural and sustainable products, international funding and incentive opportunities, export potential, and technological developments present significant opportunities for the expansion of resin production in Türkiye. Conversely, market uncertainties, international competition, and climate change are among the primary threats that could negatively affect the future of natural resin production (Caglayan, 2025). Other challenges include the shortage of trained labour, the use of non-standard production practices, the increased risk of forest fires due to wounds on tree trunks and residual resin, and several issues related to private-sector participation (Deniz, 2018).

CONCLUSION

Türkiye possesses rich forest resources suitable for resin production, with Turkish pine (*Pinus brutia*) being the most commonly utilised species and the acid-paste method emerging in recent years as the most efficient technique. Resin production in Türkiye represents a dynamic field where traditional practices and knowledge converge with modern technologies. In recent years, the widespread adoption of modern production methods has led to a significant increase

in production capacity, expanding the industrial applications of rosin, turpentine, and other resin derivatives. These developments have transformed resin into a strategic product, contributing not only to industry but also to rural employment and local economic development. While diversification in production techniques and the growing range of industrial applications offer major opportunities for the sector, they also underscore the importance of solution-oriented approaches in areas such as sustainability, raw material supply, and the development of bio-based innovations. In this context, strategic initiatives are being implemented at the national level to enhance the effective utilisation of Türkiye's resin production potential. Therefore, conducting further scientific and applied research is essential to support sectoral development.

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PRODUKCJA ŻYWICY W TURCJI: ROZWÓJ HISTORYCZNY, TECHNIKI WYTWARZANIA I ZASTOSOWANIA PRZEMYSŁOWE

ABSTRAKT

Naturalna żywica jest cennym niedrzewnym produktem leśnym o dużym znaczeniu gospodarczym i przemysłowym zarówno w Turcji, jak i w wielu innych krajach. Żywicę zaczęto produkować w starożytności przy użyciu tradycyjnych metod, z czasem wprowadzając różne udoskonalenia i innowacje, które doprowadziły do wypracowania nowoczesnych technik. W Turcji proces ten przebiegał w podobny sposób od czasów Imperium Osmańskiego po współczesność. Obecnie produkcja żywicy rozwija się, a zdolności wytwórcze rosną dzięki stosowaniu różnych metod, głównie przy wykorzystaniu dwóch gatunków: sosny tureckiej (*Pinus brutia* Ten.) oraz sosny nadmorskiej (*Pinus pinaster* Ait.). Artykuł przedstawia ogólny przegląd rozwoju historycznego pozyskiwania naturalnej żywicy sosnowej w Turcji – od przeszłości do współczesności – obejmujący techniki produkcji, zastosowania i obszary wykorzystania. Celem opracowania jest wskazanie kierunków przyszłych badań i strategii przemysłowych, które mogą wspierać rozwój tureckiego sektora żywic w kierunku globalnej konkurencyjności oraz odpowiedzialności środowiskowej.

Słowa kluczowe: żywica, metody produkcji, Turcja, sosna turecka, sosna nadmorska