

*Katarzyna ŚWIĄDER, Ph.D. assistant professor
Karina BIAŁEK, engineer

**Müge ISLETEN HOSOGLU, Ph.D. associate professor

*Institute of Human Nutrition Sciences, Warsaw University of Life Sciences – SGGW, Warsaw, Poland; Polish Society of Nutritional Sciences, Warsaw, Poland

** The Department Biotechnology, Gebze Technical University, Gebze, Kocaeli, Turkey

*Instytut Nauk o Żywieniu Człowieka, Szkoła Główna Gospodarstwa Wiejskiego SGGW, Warszawa, Polska; Polskie Towarzystwo Nauk Żywnościowych, Warszawa, Polska

** Katedra Biotechnologii, Gebze Technical University, Gebze, Kocaeli, Turcja

VARIETIES OF DATE PALM FRUITS (*PHOENIX DACTYLIFERA L.*), THEIR CHARACTERISTICS AND CULTIVATION®

Odmiany owoców palmy daktylowej (*Phoenix dactylifera L.*), ich charakterystyka i uprawa®

The date palm *Phoenix dactylifera L.*, due to deep and strong rooting, uses deep groundwater and can survive in oases in desert areas with low humidity and rainfall, even for over 100 years. It begins to bear fruit on average at the age of 5, and gives maximum yield only after 30-40 years. The date fruit is a berry consisting of skin, pulp, inner layer and seeds. There are over 600 varieties of dates around the world that differ in shape, size and properties of the fruit pulp. In addition, dates vary in color, shape and texture, depending on the ripening phase in which they are harvested: Hababouk, Kimri, Khalal, Rutab and Tamar. Appearance also depends on the type of crop and climatic conditions. In the immature state, the dates are green. However, during the ripening process, depending on the variety, they change color from yellow to red or brown. Dates also differ in water and sugar content, depending on the ripening phase. The sugar content in the early stages of ripening is about 20% of dry matter, and in ripe fruit reaches 72-88%. In terms of humidity and texture, dates are divided into fresh and soft, semi-dry and dry. About 90% of date palms are grown in the Middle East and North Africa. The main date producers are: Egypt, Saudi Arabia, Iran, Algeria, Iraq, Pakistan, Sudan, Oman United Arab Emirates and Tunisia.

Key words: *Phoenix dactylifera L.*, date palm, dates characteristics, dates varieties, cultivation.

Palma daktylowa *Phoenix dactylifera L.*, dzięki głębokiemu i silnemu ukorzeniu, korzysta z głębokich wód gruntowych i może przetrwać w oazach na terenach pustynnych o niskiej wilgotności i opadach, nawet ponad 100 lat. Zaczyna owocować średnio w wieku 5 lat, a maksymalny plon daje dopiero po 30-40 latach. Owocem daktylowca jest jagoda, składająca się ze skóry, miąższu, warstwy wewnętrznej i pestki. Na całym świecie jest ponad 600 odmian daktyli różniących się kształtem, wielkością i właściwościami miąższu owocu. Ponadto daktyle różnią się barwą, kształtem i teksturą, w zależności od fazy dojrzewania w której są zbierane: Hababouk, Kimri, Khalal, Rutab i Tamar. Wygląd zależy również od rodzaju uprawy i warunków klimatycznych. W stanie niedojrzałym daktyle są zielone. Natomiast podczas procesu dojrzewania, w zależności od odmiany, zmieniają barwę od żółtej po czerwoną lub brązową. Daktyle różnią się także zawartością wody oraz cukru, w zależności od fazy dojrzewania. Zawartość cukru we wczesnych stadiach dojrzewania wynosi około 20% suchej masy, a w dojrzałych owocach osiąga 72-88%. Pod względem wilgotności i tekstury daktyle dzielą się na świeże i miękkie, półtwarde i twarde, wysuszone. Około 90% palm daktylowych jest uprawianych w regionie Bliskiego Wschodu oraz Afryki Północnej. Głównymi producentami daktyli są: Egipt, Arabia Saudyjska, Iran, Algieria, Irak, Pakistan, Sudan, Oman Zjednoczone Emiraty Arabskie i Tunezja.

Słowa kluczowe: *Phoenix dactylifera L.*, palma daktylowa, właściwości daktyli, odmiany daktyli, uprawa.

INTRODUCTION

Date palm *Phoenix dactylifera* L., otherwise known as date palm or date tree [18] is one of the oldest cultivated plants in the world [20]. It has been cultivated in the Middle East and North Africa for over 5,000 years [8]. His homeland was most probably the Persian Gulf [21]. However, due to the fact that this plant has been cultivated since the ancient times, its origin is difficult to determine [16].

Most noble date varieties are grown around Baghdad and along the Shat-El-Arab River. Palms of very old varieties that give inferior quality fruit are grown in Egypt and Sudan. For the followers of Islam, dates from Medina are regarded as the best in the world, where according to beliefs Muhammad himself fed them [17].

CHARACTERISTICS OF A DATE PALM

Phoenix dactylifera L. belongs to the *Arecaceae* palm family and can live over 100 years [10, 21]. The date palm reaches up to 35 m in height, and the diameter of its flexible trunk can be up to 50 cm [16]. At the end of it there is a plume of large, stiff, feathery leaves 3–6 m long [21]. There may be 80 to 120 leaves on one palm. One leaf lives up to 7 years, after which it dries [16]. As for rooting of the date palm, it characterizes with the fact that it does not develop the main root. Numerous roots, which go deep into the ground in search of water, grow from the base of the trunk [1, 16]. In addition, their characteristic features is that they have uniform diameters along their entire length, about 1.5 cm [16]. Thanks to such rooting, the tree can benefit from deep groundwater and can survive for a long time in oases in desert areas [5].

The date tree is a dioecious plant - it has both female and male flowers that are very similar to each other [6, 16]. Small, yellow flowers of the date palm are collected in very large inflorescences, from which, after 5 months of pollination, about 200 fruit – dates are formed [16, 17]. One female inflorescence can contain up to 10,000 flowers, and male many times more [1, 16]. Despite the large number of flowers, there is far too little pollen for proper pollination by the means of wind. In connection with this, for thousands of years man has been interfering in the process of pollinating the date palm manually [1].

The date tree begins to bear fruit on average at the age of 5, and gives maximum yield only after 30–40 years [21]. The fruit of the date palm is an ovate-cylindrical berry called the date, and its length is up to 7 cm [1]. The date palm blooms from February to June, and reaches full maturity in late autumn, when the color of its fruit changes from green to red-yellow [14, 17]. Until they dry up and a dark brown color appears, they are left on the tree [14].

The average date palm produces 40 kg of fruit per year. With intensive crop management, the amount of produced fruit can reach up to 100 kg, while with low input, the production is only 20 kg per year [8].

CHARACTERISTICS OF THE DATE PALM FRUIT

The date fruit is monocots up to 7 cm long. The date has an oblong shape, but some species can reach a sphere-like shape [1]. The date fruit consists of exocarp (skin), mesocarp (pulp), endocarp (inner layer) and seeds (pits). Mesocarp is






Table 1. Characteristics of the most popular date varieties [5, 13, 15]

Tabela 1. Charakterystyka najpopularniejszych odmian daktyli [5, 13, 15]

Variety	Color	Characteristics
Amari	dark brown	soft, sweet, medium size fruit, eaten as dried
Barhi	amber to red-brown	soft fruit, shape broadly ovate to rounded, skin medium thick, smooth and translucent, sweet, very delicious and luscious recommended for consumption fresh at the khalal stage
Deglet Nour	dark brown	shape oblong-ovate, skin medium thick, fruit semi-dry, firm, soft with a unique taste
Fard	dark brown	semi-dry, fruit sweet and pungent shape of thick cylindrical, skin medium thick
Hadrawi	dark brown	dry dates. sweet and fleshy
Hallawy	golden brown	fruit soft, sweet, caramel-like, translucent, shape of oblong with rounded apex, skin thin
Hayani	black and shiny	soft date with not too sweet taste, fruit with an oblong shape
Kabkab	dark brown to black	soft, long shape, unripe date can be consumed after cooking and drying
Khadrawi	red to brown	fruit soft, melting and caramel-like, shape of elliptical to ovate, skin medium thick and tender
Khalas	amber to red-brown	delicious fruit, shape oblong-oval, skin thin, fruit tender, melting, translucent
Khasab	red to brown-black	shape of rounded oval, tough separating skin, fruit thick
Lulu	dark amber	soft and sweet, shape of oblong-oval, fruit thick, less fibrous flesh
Mazafati	dark brown to black	soft and fleshy, cylinder shape, desirable taste
Medjool	light brown to dark brown	fruit soft, large and sweet with an attractive appearance, consumed soft or dry
Piarom	dark brown to black	semi-dry and fleshy, long and thin shape, one of the most expensive and desirable in the world
Rabbi	red to dark brown	semi-dry and fleshy, long and thin shape
Zahidi	yellow to brown	dry, semi-dry, oblong-ovate shape, skin thick, fruit firm, not very sweet with smooth consistency

Table2. Date ripening phases [1, 2, 3, 8, 16, 19]. Source of photo [3] Available via license: CC BY-NC-SA 3.0

Tabela 2. Fazy dojrzewania daktyli [1, 2, 3, 8, 16, 19]. Źródło zdjęć [3] licencja CC BY-NC-SA 3.0

Appearance	The maturation phase	Characteristics of the fruit	Duration of the phases
	Hababouk	The fruit is round, cream-colored to light green, the fruit has a slow growth rate.	4 – 5 weeks
	Kimri	Fruits in this phase significantly increase their size and weight, are green, unripe with a high concentration of tannins	9 - 14 weeks
	Khalal	In this phase, the rate of weight gain and size decreases significantly, the fruit is already physiologically ripe, full-size, characterized by a red-yellow color, crispy and hard texture, tart taste resulting from the high content of tannins	3- 5 weeks
	Rutab	The fruit in this phase is semi-ripe, juicy, the color of the skin darkens to an amber color, brown or black, the fruit becomes less tart, and begins to soften from the top	2 – 4 weeks
	Tamar	The fruit in this phase is already fully ripe, soft, brown in color, characterized by low moisture content and high sugar concentration	2 – 4 weeks

the bulk of the fruit (85-90%), consists of epithelial cells and is divided into external and internal mesocarp [11, 13]. The flesh is surrounded by a thin layer of skin that is meant to protect the fruit [11].

However, the date seed represents 6-15% of the fruit weight, depending on the species, and is a valuable by-product of the date processing industry. The seed characterizes with the presence of a furrow of variable depth and width along its length. Seeds of different date varieties differ in the depth of the furrow. The date palm fruit seed characterizes with a high content of dietary fiber and can be used to increase the content of dietary fiber in some products [13]. The seed contains mainly insoluble fractions of dietary fiber, e.g. the date seed Deglet Noor contains 50% cellulose and 20% hemicellulose. Date seeds are mainly used in the production of animal feed [23].

DATE VARIETIES, THEIR CHARACTERISTICS AND STAGES OF RIPENING

There are over 600 varieties of dates differentiated around the world based on shape and organoleptic properties [11]. There is a significant intra-species diversity, manifesting itself in the variable shape, size and properties of the fruit flesh [21]. It is possible to guess the origin of dates by their appearance, color and taste. Table 1 presents the characteristics of the most popular date varieties.

The variety of color, shape, size and appearance of dates is shown on a selected example of date varieties grown in Libya (Fig. 1).

However, Medjool, which characterized with their large

size and attractive appearance and taste, Deglet Nour best known in the Middle East with for its unique taste and Barhi recommended for consumption at the Khalal stage belong to the most desirable date varieties [5].

In the immature state, the dates are green. However, during the ripening process, depending on the variety, they change color from yellow to red or brown [1, 21]. Maturation can be distinguished in five stages: Hababouk, Kimri, Khalal, Rutab, Tamar [1, 3] whose detailed characteristics regarding color, taste and texture changes are presented in table 2.

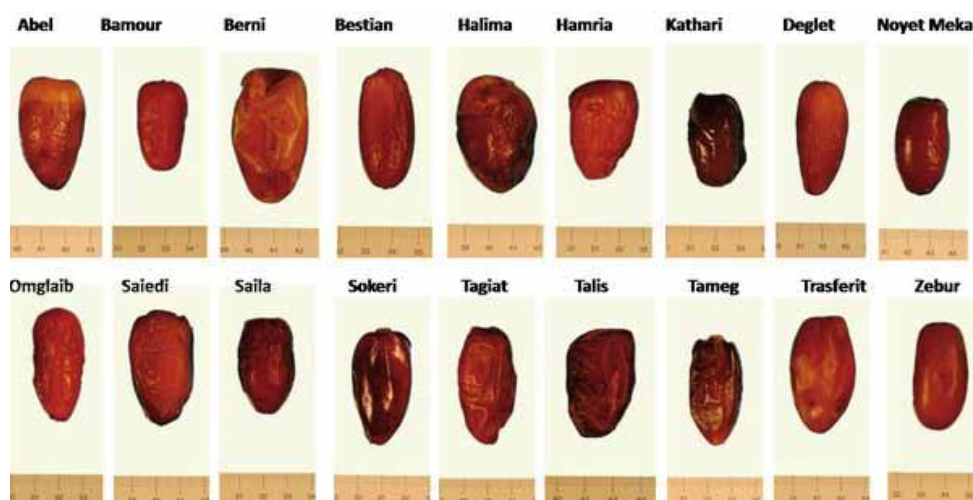


Fig. 1. Varieties of dates grown in Libya [22] Source: (IAO photograph archive).

Rys. 1. Odmiany daktyli uprawianych w Libi [22] Źródło: (IAO photograph archive).

The date variety has a huge impact on the harvest period. As a result of increasing sweetness, reducing bitterness, improving structure and juiciness, the fruits become edible in the last 3 stages of maturity Khalal, Rutab and / or Tamar [13]. The fruit with the highest nutritional value is the Khalal ripeness phase and then it is the most often consumed by the Arab population. However, for Europeans, they are too bitter [16]. Therefore, mainly fully riped dates, which are sweet, soft and juicy, are intended for export [2, 21]. They are oval in shape, reminiscent of plum and are sensitive to mechanical pressure [21]. Their fleshy pulp has a honey taste and a greasy consistency [16]. In addition, they are much easier to conserve than immature dates [2].

At Tamar, dates vary in size, shape, color, texture and taste depending on the variety, crop types and climatic conditions [8]. The shape varies from oval to cylindrical with dimensions: 3 - 11 cm in length and 2-3 cm in diameter. They are available in yellow, brown, red and black. Date varieties also differ in hardness and are classified according to humidity (Tab. 3) into three groups, soft, semi-dry and dry [4, 13, 16].

Table 3. Division of dates according to humidity and hardness [4, 13, 16]

Tabela 3. Podział daktyli w zależności od wilgotności i twardości [4, 13, 16]

Fruit hardness	Fruit moisture	Date varieties
soft	≥ 30%	Barhi, Halawy, Khadrawi, Medjool
semi-dry	20 - 30%	Dayri, Deglet Nour, Zahidi
dry	≤ 20%	Thoory

The water content of young fruits is 75-80%, and it decreases rapidly as ripening progresses. Depending on the ripening phase, the water content of dates changes, but also the sugar level changes. In the early stages of ripening, the sugar content in dates is about 20% of dry matter, and in ripe fruits it reaches 72–88% [8].

Soft dates, which are delicate and have a sweet honey flavor [17] contain mainly invert sugars (fructose and glucose), while they have a low sucrose content. Dry varieties, due to their high starch content, have a hard flesh, so in order to sense their delicate sweetness, they must be chewed and chewed for a long time [16, 17]. They also contain a relatively high sucrose content. Dry and hard dates are intended only for consumption by the local population and are highly valued especially in the Arab region [16]. In some areas, especially inhabited by a poor society, dry and hard dates are almost the only food for many months [16, 17].

According to Codex Standards for dates [9], dates are divided into cane sugar varieties containing mainly sucrose such as Deglet Noor and Deglet Beidha and invert sugar varieties containing mainly invert sugar – glucose and fructose, e.g. Barhi, Sady, Khadrawa, Halawa, Zahidi, Sayer.

The amount of sugars and the ratio between the sucrose content and invert sugars (glucose and fructose) seems to affect the moisture, consistency and hardness of the fruit. Varieties with a high sucrose content are generally hard, while those with a high content of invert sugars are usually soft [13].

CULTIVATION AND PRODUCTION OF DATES IN THE WORLD

The date palm is one of the oldest cultivated plants by humans and has been used as food for almost 6,000 years. It is grown in a very warm and dry climate. To produce a large crop, these trees require a long and intensely hot summer with low rainfall and very low humidity, especially during the pollination to harvest. Ensuring constant access to water or frequent irrigation is also key [8, 16]. The daily intake of water by an adult palm is estimated around 150 – 200 liters. Not without reason one of the old proverb says that the date palm grows „with feet in water and head on fire.” Moisture negatively affects the quality of the fruit, because high humidity leads to its cracking [19]. The ideal temperature for the growth of date palm is between 25 and 32°C [5]. For flowering it needs a temperature above 18 °C, and for fruit ripening above 25°C. However, these plants can withstand the heat up to 50°C and temporary frosts – 5°C [8]. Date palm grows on various soil types, but the best yield is obtained on sandy loams [5]. It is relatively resistant to saline and alkaline soils, which is why it can be planted in soils with varying levels of organic and mineral nutrients [8, 19]. The date palm tolerates salinity best of all cultivated fruit plants [19, 25].

In the regions of the Arabian Peninsula, North Africa and the Middle East, date cultivation is one of the most important fruit crops [8]. Due to the rapidly growing demand for dates, their production has increased significantly in recent years [1], as evidenced by, among others its introduction to production areas in South Africa, the United States, Australia, India and Mexico [8]. It is estimated that there are over 100 million trees in the area of 1 million hectares worldwide [11]. About 90% of the palm trees are grown in the warm and dry region of the Middle East and North Africa. The main producers of date fruit are: Egypt, Saudi Arabia, Iran, Algeria, Iraq, Pakistan, Sudan, Oman United Arab Emirates and Tunisia. Most dates are produced in Egypt [12]. Table 4 lists date varieties produced by the largest producers in the world.

Small date plantations are also found in Europe, including in Spain, southern Greece and the Ligurian Coast and many Mediterranean islands. Date palms are also grown near Rome, but mainly to supply the city's inhabitants with palm leaves during Palm Sunday [17].

Dates play an extremely important role in the functioning and development of the economy, society and the environment of Saudi Arabia, Egypt and Iran [8]. Date cultivation is the main source of income and is the basis of nutrition for local populations, e.g. domestic consumption in Saudi Arabia is 58 kg, and in Iraq 50 kg per person per year [8, 21]. In Egypt, Iran, Pakistan and Saudi Arabia, most of the production is directed to local markets. In contrast, Iraq, Algeria, Morocco and Tunisia focus on the export of raw material to Europe [5]. The largest date exporters include: United Arab Emirates, Pakistan, Iraq and Iran. Then Tunisia, Israel, Saudi Arabia. Egypt, Algeria and Oman have a much smaller share in exports [12]. It is estimated that around 250,000 tonnes of dates are sold on the international market [5].

India, the United Arab Emirates and Morocco belong to the largest date importers. Date exports, especially to the United States of America and the European Union, are subject to

Table 4. Countries that are the largest producers of dates and varieties of cultivated dates [4, 12, 13, 15]

Tabela 4. Kraje, które są największymi producentami daktyli i odmiany uprawianych daktyli [4, 12, 13, 15]

Country	Varieties of cultivated dates
Egypt	Amhat, Hayany, Samany, Siwi, Zoghoul
Saudi Arabia	Ajwa, Al-Barakah, Al-Qaseem, Berhi, Gur, Helwet El-Goof, Hiladi, Hulwa, Khalasah, Khasab, Majnaz, Mishriq, Miskani, Nabbut Ghraim, Nabtat Seyf, Rothanat, Ruzeiz, Sag' ai, Sebakat Al-Riazh, Sahal, Sellaj, Shashi, Sokkary, Tanjeeb, Tayyar, Thamani, Umelkhashab, Um Rahim, Zamil, Zaghoul
Iran	Allmehtari, Barhi, Dayri, Estamaran, Gantar, Halawi, Kabkab, Khassui, Khazravi, Mazafati, Mordarsang, Piarom, Pyarom, Rabbi, Sayer, Shahani, Shakkar, Sowaidani, Zahedi
Algeria	Deglet Nour, Iteema, Thoory
Iraq	Amir Hajj, Barhi, Dayri, Halawy, Khadrawi, Khastawi Maktoom, Sayer, Zahidi
Pakistan	Basra, Dhakki, Gulistan, Hsaini, Kajur, Khadrawi, Mobini, Mozafati, Obaidullah, Sabzo, Shakri, Zaidi
Sudan	Abid Rahim, Barakawi, Bentamoda, Birier, Gondaila, Jawa, Khatieb, Kulma Suda, Medina, Mishriq, Mishriq Wad, Mishriq Wad Lagi, Zughoul
Oman	Fard, Khalas, Khasab
United Arab Emirates	Berhi, Bomaan, Khalas, Lolo, Fard
Tunisia	Ammari, Angou, Arichti, Bejjou, Bistr Helou, Bouhattam, Brance de dates, Deglet Nour, Eguiwa, Ftimi, Garn ghazel, Gounda, Gousbi, Hamraya, Hissa, Kenta, Kentichi, Ksebba, Korkobbi, Lagou, Lemsi, Mattata, Mermella, Rouchdi, Touzerzayet

international marketing standards [25]. This involves, among other things, the creation of specialized farms, packaging stations and warehouses that must meet international quality requirements [5]. Dates with standardized color, size, texture, and resistance to pests and insects are widely accepted worldwide [25]. The most commonly used standards are those recommended by Codex Standards for dates [9]. The Codex limit for dates is 6% of defective fruits, regardless of whether the damage is visual or is due to the presence of dead insects [25]. At present, the lack of international standards has a negative impact on the date industry market in Saudi Arabia, United Arab Emirates, Oman, and Kuwait. These countries account for around 30% of world date production [25]. However, the need to meet international standards is associated with a reduced diversity of date species in new plantations. Growing only a few species of dates leads to an increased risk of damage caused by pests or disease [5].

APPLICATION OF DATES

Dates, depending on the species, can be consumed raw or dried [7]. They can be used to create products such as date flour, jams, juices, dietary fiber concentrates, date-based fruit bars, functional ingredients in drinks. They are used in the dairy and bakery industry [13] for the production of alcoholic beverages [21] or date butter [17]. Date syrup or date sugar can be used as a substitute for sucrose [24].

However, the big problem is the overproduction of dates, especially those of low quality, which leads to huge losses of raw material [19]. They are used to produce refined sugar, concentrated juice, confectionery pastes and fermented products [23]. Fruits of the lowest quality are dehydrated, ground and mixed with grains to create feed for camels and horses in the desert [13].

CONCLUSIONS

The cultivation of dates in the regions of the Arabian Peninsula, North Africa and the Middle East is one of the most important, which is largely due to the adaptability of the date palm to harsh climatic conditions, low humidity, lack of rainfall and high soil salinity. The cultivation of the date palm is also the main source of income, and dates are the basis of nutrition for local populations. For example, in Iraq, the consumption of dates per person per year is 50 kg. Despite the huge number of varieties of dates characterizing with various sensory, nutritional and health-promoting properties creating great possibilities of their use in the food industry, their popularity in other parts of the world is not high. In addition, despite the numerous possibilities of managing lower-quality dates, huge losses of raw material occur every year, which is why new solutions are needed to fully utilize them.

PODSUMOWANIE

Uprawa daktyli w regionach Półwyspu Arabskiego, Afryki Północnej i Bliskiego Wschodu należy do jednych z najważniejszych, co w dużym stopniu wynika ze zdolności adaptacyjnych palmy daktylowej do trudnych warunków klimatycznych, niskiej wilgotności, braku opadów i dużego zasolenia gleby. Uprawa palmy daktylowej stanowi także główne źródło dochodów, a daktyle są podstawą żywienia dla lokalnych populacji. Przykładowo w Iraku konsumpcja daktyli na jedną osobę w ciągu roku wynosi 50 kg. Pomimo ogromnej ilości odmian daktyli charakteryzujących się różnorodnymi właściwościami sensorycznymi, odżywczymi i prozdrowotnymi stwarzającymi duże możliwości ich wykorzystania w przemyśle spożywczym, ich popularność w innych zakątkach świata nie jest duża. Ponadto pomimo licznych możliwości zagospodarowania daktyli niższej jakości, co roku dochodzi do ogromnych strat surowca, dlatego potrzebne są nowe rozwiązania pozwalające na ich pełne zagospodarowanie.

REFERENCES

- [1] AL-ALAWI R., J.H. AL-MASHIQRI, J.S.M. AL-NADABI, B.I. AL-SHIHI, Y. BAQI. 2017. „Date palm tree (*Phoenix dactylifera* L.): Natural products and therapeutic options”. *Frontiers in Plant Science* 8(May): 1–12.
- [2] AL-HARRASI A., N.U. REHMAN, J. HUSSAIN, A.L. KHAN, A. AL-RAWAHI, S.A. GILANI, M. AL-BROUMI, L. ALI. 2014. “Nutritional assessment and antioxidant analysis of 22 date palm (*Phoenix dactylifera*) varieties growing in Sultanate of Oman”. *Asian Pacific Journal of Tropical Medicine* 7(S1): S591–S598.
- [3] AL-MSSALLEM I.S. et al. 2013. “Genome sequence of the date palm *Phoenix dactylifera* L.”. *Nat. Commun* 4:2274.
- [4] ASHRAF Z., Z. HAMIDI-ESFAHANI. 2011. “Date and date processing: A review”. *Food Reviews International* 27 (2): 101–133.
- [5] AUGSTBURGER F., J. BERGER, U. CENSKOWSKY, P. HEID, J. MILZ, C. STREIT. 2002. *Organic Farming in the Tropics and Subtropics*. Naturland.
- [6] BARTELS A. 2009. *Rośliny śródziemnomorskie*. Warszawa: Multico.
- [7] CHANDRASEKARAN M., A.H. BAHKALI. 2013. “Valorization of date palm (*Phoenix dactylifera*) fruit processing by-products and wastes using bioprocess technology – Review”. *Saudi Journal of Biological Sciences* 20(2):105–120.
- [8] CHAO C.C.T., R.R. KRUEGER. 2007. “The date palm (*Phoenix dactylifera* L.): Overview of biology, uses, and cultivation”. *HortScience* 42(5):1077–1082.
- [9] CODEX STANDARS FOR DATES. 1985. *Codex Stan 143–1985*. International Food Standards. Food and Agriculture Organization of the United Nations, <http://www.fao.org>.
- [10] COLDITZ G., P. COLDITZ. 1995. *Owoce egzotyczne – warzywa, owoce, orzechy*. Warszawa: Multico Oficyna Wydawnicza.
- [11] DAYANG J.F., C.R. REUBEN, F. RAJI. 2014. „Nutritional, Socioeconomic and Health Benefits of Dates”. *International Journal of Food and Nutritional Science* 3 (6): 63–73.
- [12] FAOSTAT, 2018. Food and Agriculture Organization of the United Nations, <http://www.fao.org/faostat/en>.
- [13] GHNIMI S., S. UMER, A. KARIM, A. KAMAL-ELDIN. 2017. “Date fruit (*Phoenix dactylifera* L.): An underutilized food seeking industrial valorization”. *NFS Journal*, 6(C): 1–10.
- [14] HESSAYON D.G. 1997. *Ekspert Owoce*. Warszawa: Muza SA.
- [15] KARIZAKI VAHID M. 2017. “Iranian dates and ethnic date-based products”, *Journal of Ethnic Foods* 4, 3: 204–209.

REFERENCES

- [1] AL-ALAWI R., J.H. AL-MASHIQRI, J.S.M. AL-NADABI, B.I. AL-SHIHI, Y. BAQI. 2017. „Date palm tree (*Phoenix dactylifera* L.): Natural products and therapeutic options”. *Frontiers in Plant Science* 8(May): 1–12.
- [2] AL-HARRASI A., N.U. REHMAN, J. HUSSAIN, A.L. KHAN, A. AL-RAWAHI, S.A. GILANI, M. AL-BROUMI, L. ALI. 2014. “Nutritional assessment and antioxidant analysis of 22 date palm (*Phoenix dactylifera*) varieties growing in Sultanate of Oman”. *Asian Pacific Journal of Tropical Medicine* 7(S1): S591–S598.
- [3] AL-MSSALLEM I.S. et al. 2013. “Genome sequence of the date palm *Phoenix dactylifera* L.”. *Nat. Commun* 4:2274.
- [4] ASHRAF Z., Z. HAMIDI-ESFAHANI. 2011. “Date and date processing: A review”. *Food Reviews International* 27 (2): 101–133.
- [5] AUGSTBURGER F., J. BERGER, U. CENSKOWSKY, P. HEID, J. MILZ, C. STREIT. 2002. *Organic Farming in the Tropics and Subtropics*. Naturland.
- [6] BARTELS A. 2009. *Rosliny srodziemnomorskie*. Warszawa: Multico.
- [7] CHANDRASEKARAN M., A.H. BAHKALI. 2013. “Valorization of date palm (*Phoenix dactylifera*) fruit processing by-products and wastes using bioprocess technology – Review”. *Saudi Journal of Biological Sciences* 20(2):105–120.
- [8] CHAO C.C.T., R.R. KRUEGER. 2007. “The date palm (*Phoenix dactylifera* L.): Overview of biology, uses, and cultivation”. *HortScience* 42(5):1077–1082.
- [9] CODEX STANDARS FOR DATES. 1985. *Codex Stan 143–1985*. International Food Standards. Food and Agriculture Organization of the United Nations, <http://www.fao.org>.
- [10] COLDITZ G., P. COLDITZ. 1995. *Owoce egzotyczne – warzywa, owoce, orzechy*. Warszawa: Multico Oficyna Wydawnicza.
- [11] DAYANG J.F., C.R. REUBEN, F. RAJI. 2014. „Nutritional, Socioeconomic and Health Benefits of Dates”. *International Journal of Food and Nutritional Science* 3 (6): 63–73.
- [12] FAOSTAT, 2018. Food and Agriculture Organization of the United Nations, <http://www.fao.org/faostat/en>.
- [13] GHNIMI S., S. UMER, A. KARIM, A. KAMAL-ELDIN. 2017. “Date fruit (*Phoenix dactylifera* L.): An underutilized food seeking industrial valorization”. *NFS Journal*, 6(C): 1–10.
- [14] HESSAYON D.G. 1997. *Ekspert Owoce*. Warszawa: Muza SA.
- [15] KARIZAKI VAHID M. 2017. “Iranian dates and ethnic date-based products”, *Journal of Ethnic Foods* 4, 3: 204–209.

- [16] **LAMER-ZARAWSKA E. 2000.** Owoce egzotyczne. Wrocław: Astrum.
- [17] **LEWKOWICZ-MOSIEJ T. 2013.** Egzotyczne owoce. Kraków: Wydawnictwo M.
- [18] **MACIUDZINSKA-KAMCZYCKA M. 2014.** „Phoenix dactylifera/Judaea dactylifera. Palma daktylowa jako „symbol żydowski” w świecie grecko-rzymskim”. *Studia Europaea Gnesnensia* 9:105–125.
- [19] **MANICKAVASAGAN A., M. MOHAMED ESSA. E SUKUMAR. 2012.** Dates: Production, Processing, Food, and Medicinal Values (Medicinal and Aromatic Plants – Industrial Profiles. Floryda: CRC Press.
- [20] **PARVIN S., D. EASMIN, A. SHEIKH, M. BISWAS, S.CH.D. SHARMA, MD.G.S. JAHAN, MD.A. ISLAM, N. ROY, M.S. SHOYON. 2015.** “Nutritional Analysis of Date Fruits (Phoenix dactylifera L.) in Perspective of Bangladesh”. *American Journal of Life Sciences* 3(4):274–278.
- [21] **PODBIELKOWSKI Z. 1992.** Rośliny użytkowe. Warszawa: Wydawnictwo Szkolne i Pedagogiczne.
- [22] **RACCHI M., A. CAMUSSI. 2018.** “The date palms of Al Jufrah-Libya: A survey on genetic diversity of local varieties”. *Journal of Agriculture and Environment for International Development* 112(1):161–184.
- [23] **SHAFIEI M., K. KARIMI, M. J. TAHERZADEH. 2010.** “Palm date fibers: Analysis and enzymatic hydrolysis”. *International Journal of Molecular Sciences* 11(11):4285–4296.
- [24] **SWIĄDER K., A. TRYBULA, D. SREDNICKA-TOBER, E. HALLMANN. 2018.** „Syropy i melasy jako naturalne zamienniki cukru”. *Przemysł Spożywczy* 72(1): 34–37.
- [25] **WAKIL W., J.R. FALEIRO, T. A. MILLER, G.O. BEDFORD, R.R. KRUEGER. 2015.** Sustainable Pest Management in Date Palm: Current Status and Emerging Challenges. Switzerland: Springer, Cham.
- [16] **LAMER-ZARAWSKA E. 2000.** Owoce egzotyczne. Wrocław: Astrum.
- [17] **LEWKOWICZ-MOSIEJ T. 2013.** Egzotyczne owoce. Krakow: Wydawnictwo M.
- [18] **MACIUDZINSKA-KAMCZYCKA M. 2014.** „Phoenix dactylifera/Judaea dactylifera. Palma daktylowa jako „symbol żydowski” w świecie grecko-rzymskim”. *Studia Europaea Gnesnensia* 9:105–125.
- [19] **MANICKAVASAGAN A., M. MOHAMED ESSA. E SUKUMAR. 2012.** Dates: Production, Processing, Food, and Medicinal Values (Medicinal and Aromatic Plants – Industrial Profiles. Floryda: CRC Press.
- [20] **PARVIN S., D. EASMIN, A. SHEIKH, M. BISWAS, S.CH.D. SHARMA, MD.G.S. JAHAN, MD.A. ISLAM, N. ROY, M.S. SHOYON. 2015.** “Nutritional Analysis of Date Fruits (Phoenix dactylifera L.) in Perspective of Bangladesh”. *American Journal of Life Sciences* 3(4):274–278.
- [21] **PODBIELKOWSKI Z. 1992.** Rosliny uzytkowe. Warszawa: Wydawnictwo Szkolne i Pedagogiczne.
- [22] **RACCHI M., A. CAMUSSI. 2018.** “The date palms of Al Jufrah-Libya: A survey on genetic diversity of local varieties”. *Journal of Agriculture and Environment for International Development* 112(1):161–184.
- [23] **SHAFIEI M., K. KARIMI, M. J. TAHERZADEH. 2010.** “Palm date fibers: Analysis and enzymatic hydrolysis”. *International Journal of Molecular Sciences* 11(11):4285–4296.
- [24] **SWIADER K., A. TRYBULA, D. SREDNICKA-TOBER, E. HALLMANN. 2018.** „Syropy i melasy jako naturalne zamienniki cukru”. *Przemysl Spozywczy* 72(1): 34–37.
- [25] **WAKIL W., J.R. FALEIRO, T. A. MILLER, G.O. BEDFORD, R.R. KRUEGER. 2015.** Sustainable Pest Management in Date Palm: Current Status and Emerging Challenges. Switzerland: Springer, Cham.