BAYBURT ÜNİVERSİTESİ

ICADET

4th INTERNATIONAL Conference on Advanced Engineering Technologies

PROCEEDINGS

28-29-30 September 2022

BAYBURT / TURKEY

Güvenli Şehrin Huzurlu Üniversitesi www.bayburt.edu.tr

Bayburt University Publication | Issue No: 34
ISBN: 978-605-9945-35-6

Kitchen Waste to Methane Gas: Anaerobic Digestion for Community
Mohammad Hakim CHE HARUN, Nurul Fasihah MOHD ASRI 58

Synergistic Effect of Spiralled Multiwalled Carbon Nanotubes/barium Hexaferrite (MWCNTs/$BaFe_{12}O_{19}$) Nybrid for Electromagnetic Wave Absorption in X- and Ku-band
Ismayadi ISMAIL, Raba'ah Syahidah AZIS, Nurhidayaty MOKHTAR, Nurshahiera ROSDI 77

Investigation of Usability of Aggregates in Kırşehir Region
İlhami DEMİR 78

The Role of Leader Countries in the Dry Fig Market of the World
Seval KURTOĞLU, Ahmet Semih UZUNDUMLU, Duygu TOSUN 87

Effect of Different Extraction Methods and Solvents on Bioactive Compounds of Lavender
Naciye KUTLU KANTAR 95

Freeze-Thaw Resistance of Road Pavement Concrete Produced with Self-Compacting Concretes with Different Steel Fiber Ratios
E. Ebru DEMİRCİ, Fatma KARAGÖL 102

Potential Application of Copperas and Calcium Hydroxide for Industrial Effluent Treatment
Sofiah HAMZAH, Mohammad Hakim CHE HARUN, Nurul Aqilah MOHAMAD, Mohd. Salleh Amri ZAHID, Ahmad Ariff Fahmi MUSTOFA, Sa'adah LATFI, Suhaimi MOHD ARIPIN, Rozano SAAD 113

Current Structure and Problems in Migrating Beekeeping Enterprises in Turkey
Ferda Nur Özdemir, Erol ÖZBEK, Adem AKSOY 118

Changes in Some Chemical Properties of Black Mulberry Concentrate During Storage
Oğuzhan YAVAŞ, Memnune ŞENGÜL, Melek ZOR 126

Isolation of a Halotolerant Bacillus Sp. for Protease Production from Kali Estuary
Suresh ARAKERA, Sujal REVANKAR, Lucky THAKKAR 139

Chocolate Coated Cereal Bar Design with Puffed Buckwheat: Puffing Efficiency and Physical Properties
Seher Nur SAHIN, Afranur DONMEZ, Dilara BOYDAK, Sevil CIKRIKCI ERUNSAL 140

Investigation of Biochar Additive as a Performance Enhancer in Asphalt Coatings
Mustafa Taha ASLAN, Tuba KUTUK, Erol ISKENDER, Atakan AKSOY, Cansu ISKENDER 141

An Overview of Metal–Organic Framework (MOF) for Green Engineering Applications
Mohd Hafizuddin AB GHANI, Ismayadi ISMAIL, Rosnah NAWANG, Siti Zulaika RAZALI, Che Azurahanim CHE ABDULLAH, Nishata Royan RAJENDRAN ROYAN 149

A Study on Forecasting of Avocado Consumption Per Capita in Turkey in the 2022-2027 Periods
Ahmet Semih UZUNDUMLU, Duygu TOSUN, Seval KURTOĞLU 150

Active Nano Biopolymers and Food Packaging Applications
Kübra CANPOLAT 156

Effects of Co-Inoculation of Microbial Biostimulants on Cucumber Growth, Yield and Fruit Quality at Different İrrigation Levels under Field Conditions
Seyhmus BİCER, Ceknas ERDINC, Nuray COMLEKCIOGLU 162

Investigation of the Factors Causing Salinization in the Tarsus Coastal Plain Aquifer (Mersin, Turkey) Using Ionic Ratios and Graphical Methods
Onur GÜVEN, Cüneyt GÜLER, Mehmet Ali KURT, Ümit YILDIRIM 163

Evaluation of Groundwater Nitrate Pollution by Nitrate Pollution Index (NPI): A Case Study of Tarsus Coastal Plain Aquifer (Mersin, Turkey)
Onur GÜVEN, Cüneyt GÜLER, Mehmet Ali KURT, Ümit YILDIRIM 164

Pneumonia Detection with Different Classifiers in the Hybrid Model Approach
Rabiye KILIÇ, Hilal Kübra SAĞLAM, Emin Argun ORAL, İbrahim Yücel ÖZBEK 170

Gluten Free Tarhana: A Review
Gülşah ÇALIŞKAN KOÇ, Ayşe Nur YÜKSEL, Yeliz TEKGÜL 177

Seismic Assessments in Elazig Province, Turkey
Yusuf GÜZEL, Fidan GÜZEL 178

Drying kinetics and quality analysis of turmeric slices using IRHAD
Jeevarathinam GANESAN, Ravi PANDISELVAM, Dinesh KUMAR SHANMUGASUNDARAM, Dillwyn STEPHEN, Nivetha THANGARAJ, Changanedassery Sainjan NEETHU 185

Characterization of Biodegradable Packaging using Polylactic Acid and Ethyl Cellulose Composite
Dillwyn STEPHEN, Nivetha THANGARAJ, Changanedassery Sainjan NEETHU, Jeevarathınam GANESAN, Ravi PANDISELVAM 186

4th International Conference on Advanced Engineering Technologies

28-30 September 2022

A Study on Forecasting of Avocado Consumption Per Capita in Turkey in the 2022-2027 Periods

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Keywords:
Avocado
Export
Forecast
Production
Turkey

Abstract

Avocado is called an old world's new fruit and has a rising value with nutritional and health effects developments. In terms of health, the importance of this product has increased in recent years, and therefore production, yield, import, and export values of avocado were examined in this study. In this context, avocado production, yield, import, and export values were researched in leading countries, and also these data will be evaluated in terms of provinces and districts in Turkey. TURKSTAT, FAOSTAT, and ITC data and studies on the subject were used to achieve these purposes. The ARIMA model is used in production and export forecasts for 2022-2027. Avocado is produced in 64 countries in the world, and the leading countries in production are ranked as Mexico with 31.56%, the Dominican Republic with 9.18%, Peru with 7.26%, Colombia with 6.70%, Indonesia with 6.48%, Kenya with 3.61%, Brazil with 3.45%, and 3.10% with the USA respectively in 2011-2020 periods. On the other hand, Turkey ranks 45th in the world with a production of 2,606 tons and a share of 0.04%. With a production share of approximately 80% in Turkey, Antalya ranks first in terms of production area and amount. Mersin with 16%, Muğla with 3%, and Hatay with 1% are following this province in the same period. The annual per capita consumption of this product, which has a high export potential due to its high consumption by Western countries with a high-income level, is 1.05 kg in the world, while it is 0.18 kg in Turkey. Turkey started with 100 tons of production in 1988 and reached 6,000 tons in 2020. Exports increased from 72 tons to 869 tons and imports from 4 tons to 3,677 tons in Turkey in 1988 and 2021. It is thought that estimating avocado production and per capita consumption in the 2022-2027 period will contribute to increasing local consumer demands by assisting the marketing understanding of producers, exporters, and importers in this study.

1 INTRODUCTION

There are various factors affecting human health and humans require adequate and balanced nutrition to lead a healthy life [1]. If, on the contrary, the nutrient needs of the body are not adequately met, resistance to diseases decreases, treatment time is prolonged, and this process becomes difficult and expensive [2]. In this case, the importance of vitamins and minerals required in a balanced diet is increasing day by day [3]. Hence, the demand for many foods has increased in recent years, which have become increasingly important in studies and provide important information to consumers. The increased demand for avocados, one of these foods, has significantly increased its production [4, 5].

Although Mexico is known to be the homeland of avocados, the discovery of this fruit buried with a mummy in Peru in the 8th century BC has confused [6]. Avocados have been given various names, some according to their shape, others according to their content. Some of them have been given names such as alligator pear, American pear, and poor man's butter [4, 6, 7].

The avocado, which is an evergreen subtropical fruit [8], is anatomically divided into 3 parts, with the kernel constituting 20% of its content, the fleshy fruit constituting 65%, and the outermost green peel constituting 15% [7], and is grown in 72 countries in 5 continents around the world [9]. The fruit part of the avocado is quite fleshy and the fruit cannot reach eating maturity before a certain period after it is plucked from the tree, just like bananas,

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and it is consumed when it matures and becomes the consistency of butter [10]. Avocado is considered to be the most nutritious of all fruits due to its unique texture, great taste and aroma, nutritional profile, and the many benefits it provides to humans [11]. Avocado contains vitamins B1 (thiamine), B2 (riboflavin), B3 (niacin), B5, B6, E, K, and minerals Mg, Zn, Fe, Cu, Mn, and P. In addition, avocado is one of the most important fruits for people with weight-related health problems due to its high fiber and fat content (the fattiest fruit in the world), low carbohydrate and saturated fat content, and no sodium [12]. The significance of avocado oil stems from its unsaturated oleic acid content, which lowers cholesterol levels that cause heart disease [7, 13]. It also has a higher vitamin and fiber content than other foods, adding to its value. In addition to their nutritional value, avocados are also used in the food and cosmetics industry [4, 6]. According to data for 2020, avocado production is carried out in 64 countries in the world, and the leading countries in production are Mexico with 29.70%, Colombia with 10.88%, the Dominican Republic with 8.39%, Peru with 8.19%, Indonesia with 7.56%, Kenya with 4.00% and Brazil with 3.31% [9]. Out of approximately 500 avocado varieties in the world, 7 of them are grown in Turkey, namely Bacon, Fuerte, Hass, Zutano, Ettinger, Pinkerton, and Wurtz [14]. As of 2020, avocado production in Turkey, which ranks 41st in the world avocado production with a production of 5,923 tons, is carried out in 4 provinces. Antalya ranks first with a share of 80.59% and the other producing provinces are Mersin with 16.15%, Muğla with 2.55%, and Hatay with 0.71% [14].

The market price of avocado is quite high because its production areas require climatic conditions in certain regions, its nutritional value is high and its flavor is unique. According to data from 2021, Turkey imports 6,368 tons of avocados, and the countries importing are Kenya, Chile, Israel, Colombia, and South Africa. Kenya imports the most with 79.28%. In 2021, Turkey exported 522 tons of avocados (5.75% of its production) to many countries such as Ukraine, Iraq, Bulgaria, and Romania. Turkey's avocado export opportunities are quite high due to its high consumption by Western countries with high-income levels [15]. According to data from 2020, world avocado consumption was 1.05 kg [9, 15], while the consumption in Turkey in 2021 was 0.18 kg [14, 15]. The objective of this study is to examine the developments in the avocado sector, which is a rising value in the world, and in Turkey, which is a functional food with nutritional health benefits. Production, yield, import, and export values of the product in the world and Turkey were analyzed to this end.

2 MATERIAL AND METHOD

2.1 Material

The main material of the study consists of Turk Stat, FAO, and ITC data. In addition, studies on the subject were also utilized. Avocado production, export, and import data for the period 1988-2021 in important avocado-producing countries were evaluated in this context.

2.2 Method

2.2.1 ARIMA Models

ARIMA (autoregressive-integrated-moving average) model is one of the models that use time series data to forecast the future. A significant effort has been made in recent years to develop and improve time series forecasting models, and various forecasting methods have been used that utilize linear and nonlinear models separately or in combination [16]. In general, a certain prediction algorithm is applied in time series analysis without examining the characteristics of the series very carefully, while in ARIMA models, the characteristics of the series are examined in detail and the most appropriate prediction algorithm is tried to be obtained by determining the appropriate model for the data [17]. The ARIMA method also referred to as Box-Jenkins, has been successfully applied to univariate time series [18, 19]. Moreover, this model can be applied to stationary and non-stationary series and the stationarity of the mean and variance of the series is ensured [17]. It is called ARMA if the series to which it is applied is stationary, (ARIMA) if non-stationary, and (SARMA) if seasonal [18]. When the non-seasonal models are non-stationary, they are denoted as ARIMA(p,d,q), when stationary (since d=0), the model is expressed as ARIMA(p,0,q) or ARMA(p,q) [17]. ARIMA is a linear time series forecasting method widely used in many applications, including finance, engineering, social sciences, and agriculture. ARIMA models are an integration of Autoregressive models (AR) and Moving Average models (MA)[16]. ARIMA models provide good accuracy in forecasting relatively stationary time series data. Nevertheless, it makes a strong assumption that future data values depend linearly on current and past data values [16]. An ARMA model expresses the conditional mean of Yt as a function of both past observations (Y_{t-1}, Y_{t-2},…… Y_{t-p}) and past innovations (ε_{t-1}, ε_{t-2},…… ε_{t-q}). Where p, the number of past observations on which Yt depends, is the degree of AR, while q, the number of past innovations on which Yt depends, is the degree of MA [20]. The ARIMA method takes into account historical data and decomposes them into an AR process, where there is a memory of past events, an integrated (I) process

that explains the stabilization or rationalization of data and facilitates forecasting, and the longer the historical data with MA, the more accurate this method forecasts as information flows over time [21].
In order to conduct time series analyses, the series should be stationary, that is, the error terms of the applied model should exhibit white noise [22]. If there is white noise in the series, the ARIMA method estimates ARMA(p,q) [23]. In the absence of white noise, unit root search in the series is performed with the Dickey-Fuller test and the series are determined to be non-stationary and the data are usually stationary by taking the first-order difference, but in some cases, the data are stationary by taking the second or third order difference [20, 24]. This situation is expressed as follows [24, 25]

d=0: $y_t = Y_t$ (1)
d=1: $y_t = Y_t - Y_{t-1}$ (2)
d=2: $y_t = (Y_t - Y_{t-1}) - (Y_{t-1} - Y_{t-2}) = Y_t - 2Y_{t-1} + Y_{t-2}$ (3)

The ARIMA model is a generalized version of the ARMA model and the ARMA model is expressed as in formula (4) [20].

$$Y_t = \alpha + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \cdots + \beta_p Y_{t-p} + \varepsilon_t + \phi_1 \varepsilon_{t-1} + \phi_2 \varepsilon_{t-2} + \cdots + \phi_q \varepsilon_{t-q} \quad (4)$$

In order to forecast with ARIMA, some features need to be taken into account. There are 4 of these features [26]:
1. The stationarity of the data should be checked with root tests, and if there is no stationarity, stationarity should be obtained at lags of 1st, 2nd or 3rd years,
2. Conformity of the data to a normal distribution should be ensured,
3. There should be no outliers in the data and
4. There should be no missing values for any year in the data.
Several criteria are used to determine the best ARIMA models, the most preferred being the Akaike Information Criteria (AIC) and Bayesian Information Criteria (BIC) [23]. In the study, the p and q values that obtained the BIC values determined by SCAN and ESACF in SAS 9.4 program were analyzed separately and the p and q values that met these criteria the most according to the results of the smallest SBC, SSE, MSE, MAE, MAPE, RMSE, DW closest to 2.00 and the highest R^2 were accepted as the most appropriate ARIMA model.

3 RESULTS

Production, imports, exports, and per capita consumption data obtained from FAO, TurkStat, and ITC for the years 1988-2021 and per capita consumption data calculated by taking into account these three data and population into account, averages of 5 or 6 year periods are calculated and estimates for the years 2022-2027 and the average of these years are given in Table 1.

Table 1. Avocado production, export-import quantity, and value, price, and consumption status in Turkey in five or six-year periods

Variables \ Periods	1988-1992	1993-1997	1998-2003	2004-2009	2010-2015	2016-2021	2022-2027
a. Production Amount (tons) ARIMA (5,1,1)	86	157	329	738	1.543	3.310	10.877
b. Export Amount (tons) ARIMA (0,1,3)	31	23	10	10	17	360	284
c. Import Amount (tons) ARIMA (1,1,0)	2	12	15	96	256	1.766	12.786
d. Population Amount (1.000 persons)	53,912	58,500	63,714	69,166	75,351	81,597	86,549
e. Consumption (kg/person) (a+c-b)/d	0.001	0.002	0.005	0.012	0.024	0.058	0.270
f. Export Value (1,000 $) ARIMA (0,1,0)	20	9	9	28	20	595	1,018
g. Import Value (1,000 $) ARIMA (1,1,0)	1	12	11	132	255	1.290	5.423
h. Export Price ($/kg) (f/b)	0.65	0.39	0.90	2.80	1.18	1.65	3.58
i. Import Price ($/kg) (g/c)	0.50	1.00	0.73	1.38	1.00	0.73	0.42

Note: Data for 2022-2027 are calculated from ARIMA model forecasts.
FAOSTAT population projections were used for population values.

The ARIMA forecasting model is used to forecast the future production of many crop production activities. However, as is known, there are few studies in Turkey that make avocado production forecasts for the coming years. These studies, which discuss the current situation and forecast, are very important for the increase and sustainable continuation of avocado production in Turkey [27]. They forecasted that avocado production will increase from 2004 tons to 3156 tons between 2016-2025 with the Brown exponential smoothing model. ARIMA (5,1,1) model was used to forecast avocado production in Turkey for the years 2022-2027. While the average production in the first 5 years of avocado production in Turkey (1988-1992) was 86 tons, the data for 2016-2021 shows that production reached 3.310 tons. Avocado is produced in 4 provinces in Turkey. Antalya ranks first with 80.59%. The other provinces that produce are Muğla, Mersin, and Hatay. Looking at the forecasts covering the next 6 years, production is expected to reach 10.877 tons between 2022 and 2027. When the amount of avocado exported is examined, according to the average data for 2016-2021, the highest amount of avocado exports so far was 360 tons [28]. According to the study, the amount of avocado exports for the years 2016-2020 has shown a continuous increase and is 130, 299, 451, 687, and 887 tons respectively. It will be seen in the research we have conducted that the results are parallel. In the light of these data, while 30 tons of avocado were exported in 1988-1992, it is forecasted with ARIMA (0,1,3) model that exports will increase to 284 tons and sales will be made by 3.58 $/kg between2022-2027. The highest amount of avocado exports was 360 tons between 2016 and 2021 at $1.65/kg.

When the amounts of avocado imported since 1988 are analyzed, according to the average data for 2016-2021, the highest import has been realized with 1.766 tons. As can be seen, Turkey is an importing country. This is because production has not yet reached the desired levels [29]. There are 2 avocado markets in the world, the US and Europe. The formation of a new market is not expected. [30] calls the avocado a 'newborn baby' whose market structure has just been completed. The phrase 'time to wake the sleeping beauty is used for the world avocado trade [31], The countries that have a say in imports in the world are Mexico, Chile, and Peru, which are also in the first place in production. But an important aspect here is the distribution of avocados. Voyage times are between 14-20 days for distribution by sea. It is very important that the avocado, which has a soft structure, reaches the market without being damaged. Despite having very low production, Israel has also taken its place in imports as it has a 3-day sea distance to the European market. Turkey's estimated imports for 2022-2027 were analyzed with the ARIMA (1,1,0) model and estimated as 12.786 tons. Its value was found as 5.423 ($1,000). The fact that the import prices of the product are decreasing day by day directs consumers to imported varieties and makes it difficult for the producers in the country to fight against these low-priced varieties. The import price of avocado is forecasted to decrease from $0.73/kg in 2016-2021 to $0.42/kg in 2022-2027. Looking at per capita consumption, it was 0.001 kg, in 1961-1970, and 0.270 kg, in 2021-2027 periods.

4 CONCLUSION

Avocado production and foreign trade data for the years 1988-2021 in the world and Turkey were analyzed and production forecasts for the years 2022-2027 were made with the ARIMA model. It is forecasted that avocados, the world's rising trend and the precious of western countries, will experience a significant increase in production in Turkey between 2022 and 2027. Avocado production, which was 86 tons between 1988-1992, is expected to reach 10.877 tons between 2022-2027. Examining the export values, it is thought that avocado exports, which were 31 tons between 1988-1992, will increase to 284 tons in 2022-2027. The highest amount of avocado export was made between 2016 and 2021 with 360 tons. The highest imports were made by countries such as Mexico, Peru, and Chile, which are considered the homeland of avocados. While 2 tons of avocados were imported for $0.50/kg in 1988-1992, 12.786 tons of avocados are expected to be imported for $0.42/kg between 2022-2027. While per capita avocado consumption in Turkey was 0.001 kg/person in 1988-1992, it is expected to increase to 0.322 kg/person in 2022-2027. The avocado's content, its nutritional value, and its uses extending to the oil industry undoubtedly increase the demand for avocados. Therefore, it is extremely important to increase the production and export of high-value-added avocados in Turkey. Policies should be developed to ensure sustainability in production. Turkey's Mediterranean coastline is highly suitable for avocado production. Therefore, the number of provinces producing avocados should be increased. It should be ensured that this situation is well utilized and avocado production and consumption should be made widespread like banana production and consumption. It is expected that producer support prices will be increased or input prices will be reduced in response to rising input prices. Individuals should be better informed about the contributions of avocados to human health. Attempts should be made to popularize the product by organizing festivals with the theme "Healthy Days with Avocado".

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