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Estimating Chicken Meat Productions of Leader Countries for 2019-2025 Years

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ABSTRACT: *The study predicted chicken meat production in 2019-2025 period for the leading chicken-producing countries with the help of the 1961-2018 Food and Agriculture Organization (FAO) data since chicken meat consumption is so high worldwide. The USA ranks the first place while Brazil and China take second and third places, respectively. The analysis of the pioneer chicken meat-producing countries indicates that while the portion of the USA in world production decreases, the share, particularly Brazil and China, will approach that of the USA. World chicken meat production, which was 7.56 million tons in 1961, will increase to 139.19 million tons in 2025, and this production per capita is predicted to increase to 17.0 kg in 2025 from 2.4, 5.35, 9.80, and 15.0 kg in 1961, 1981, 2001, and 2018, respectively. Indonesia, Russia, Brazil, Japan, and India will run the highest increases in production. However, the share of countries in chicken meat production will decrease from 61% to 60% in 2019-2025 compared to the 2012-2018 periods. This condition showed that apart from some leading countries, the production will keep a rapid increase in production. The increase in chicken meat production and chicken meat import worldwide will improve human nutrition, especially in developing and underdeveloped countries. Countries that run cost advantages and high-quality life standards in line with technological innovations produce processed chicken products, strengthen animal health, hygiene, and transportation standards, and attach importance to advertising activities that increase consumer demand will be more advantageous in this market.*
Key words: *ARIMA model, world meat production, leading countries, prediction, poultry farming.*

Estimando a produção de carne de frango em países líderes para os anos 2019-2025

RESUMO: *O estudo visa prever a produção de carne de frango no período de 2019-2025 para os principais países produtores de frango com a ajuda dos dados da Organização para Agricultura e Alimentação (FAO) de 1961-2018, uma vez que o consumo de carne de frango é tão alto emtodo o mundo. Os EUA ocupam o primeiro lugar, enquanto o Brasil e a China ficam com o segundo e o terceiro lugares, respectivamente. A análise dos países pioneiros na produção de carne de frango indica que enquanto a participação dos EUA na produção mundial diminui a participação, principalmente do Brasil e da China, se aproximará da dos EUA. A produção mundial de carne de frango, que era de 7,56 milhões de tonelada sem 1961, aumentará para 139,19 milhões de tonelada sem 2025, e esta produção per capita deve aumentar para 17,0 kg em 2025 de 2,4, 5,35, 9,80 e 15,0 kg em 1961, 1981, 2001 e 2018, respectivamente. Indonésia, Rússia, Brasil, Japão e Índia terão os maiores aumentos de produção. No entanto, a participação dos países na produção de carne de frango cairá de 61% para 60% em 2019-2025 em relação ao período de 2012-2018. Essa condição mostra que, além de alguns países líderes, a produção manterá um rápido aumento da produção. O aumento na produção e importação de carne de frango em todo o mundo melhorará a nutrição humana, especialmente nos países em desenvolvimento e subdesenvolvidos. Os países que possuem vantagens de custo e padrões de vida de alta qualidade alinhados às inovações tecnológicas produzem produtos processados de frango, fortalecemos padrões de saúde, higiene e transporte animal e atribuem importância a atividades de publicidade que aumentem a demanda do consumidor serão mais vantajosas neste mercado.*
Palavras-chave: *modelo ARIMA, produçãomundial de carne, paíseslíderes, previsão, avicultura.*

INTRODUCTION

The amount of protein consumed per person per day is more significant in healthy and balanced nutrition (ALPARSLAN & DEMIRBAS, 2020). Protein, minerals and vitamins required for healthy and balanced nutrition are obtained from plant and animal sources (SARKER et al., 2020). Chicken meat, one of the animal protein sources, is more economical due to the short production period and provides people with quality protein at low prices (KESKIN & DEMIRBAS, 2012).

An individual needs 0.8 grams of protein per kilogram of body weight daily, which is emphasized by the fact that proteins are a nutrient that cannot be stored in the human body (WU, 2016) and

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must be taken from the outside in equal proportions in three meals (KENIJZ et al., 2020). In studies conducted in the 1980s and 1990s, it was emphasized that at least 40% of the proteins that should be taken daily should come from higher-quality animal products (GOGUS, 1986). There are some studies in the 2000s that suggested this ratio should be 50-66% (DEMIRKOL, 2007).

The increase in income per capita worldwide has arisen the consumption rate of animal products (GIBSON, 2011). On the one hand, grain and plant-based nutrition stay mostly dominant in underdeveloped and developing countries. On the other hand, animal product-based nutrition consumes a higher rate in developed countries. Moreover, the consumption of meat and meat products rise in developing countries in the 2000s (UZUNDUMLU et al., 2011). The increasing demand for animal products throughout the world stems from both the increasing income per capita (GIBSON, 2011) and the content of these products, such as high and quality protein and minerals, such as iron and zinc, and vitamin B12, which are essential for the adequate and balanced diet of individuals (ELANGO et al., 2009; GIBSON, 2011). According to the global predictions of the Food and Agriculture Organization (FAO, 2021), while the consumption of meat, egg, and milk is expected to increase by 23-30% between 2000 and 2020, it is proposed that this increase may reach 2-6% in developed countries and up to 60% in developing countries. According to ALEXANDRATOS & BRUINSMA (2012), meat consumption per capita universally will increase from 38.7 kg to 49.4 kg between 2005 and 2050, accounting for a 28% increase.

As food source, meat has a significant share in the international economy. According to 2019 data, meat was produced approximately 207 million tons obtained from cattle, sheep, goats, and buffalo worldwide. Chicken meat constituted 57% of this quantity, cattle meat 33%, sheep meat 5%, goat meat 3%, and buffalo meat 2%. The chicken meat was produced 118 million tons worldwide, and 17% of this quantity was provided by the USA, 12.3% by Brazil, 11.5% by China, 4% by Russia, and 3.5% by India. In addition, 16.9 million tons of chicken meat, including 14.7 million tons of unprocessed chicken meat and 2.2 million tons of processed chicken, was exported in the same period, and 24% of this quantity came from Brazil, 20.5% from the USA, 8.4% from the Netherlands, 6.2% from Poland, 3.5% from China, 3.1% from Belgium, and 3% from Turkey. In the same period, approximately 12.8 million tons of unprocessed chicken meat and 2.2 million tons of processed chicken meat were imported, and 7.2% of total chicken importing were run by Japan, 5.8% by Mexico, 5.7% by China, 4.8% by Hong Kong, 4.3% by Saudi Arabia, and 4.3% by Germany (FAO, 2021).

Some of the reasons for the high competitiveness of chicken meat include production costs, use of technology, nutritional trends, and faster capital turnover compared to other livestock sectors (KRANJAC, 2019).

The data are obtained and organized by specific criteria that can be evaluated easily. Series are divided into five by time dimension, space, panel data, composite, and frequency distribution series. A time series may be a set of perceptions taken at indicated times, by large measured at usual intervals. These series are as often as possible utilized in all areas of science, for the most part in future-oriented expectations (AKDI, 2012). Time arrangement information is orchestrated successively, agreeing to a yearly, month to month, week after week, every day, or hourly time arrangement (AKMAN & BEKTAS, 2017). They are separated into two organizing, with the first one being univariate time series and the second one being multivariate time series according to the number of variables used. Since many time series are only time-dependent observations, they generally do not have other explanatory variables. Therefore, many analysts utilize univariate time series when making estimates by used time series. Models of univariate series are divided into models according to whether the retrospective data have a linear-non-linear function. These models are called linear-nonlinear models (BUYUKSAHIN & ERTEKIN, 2020). The Box-Jenkins strategy (ARIMA show) that the initial broadly utilized and comprehensive tactic, in time series prediction, is a straight model (ATESONGUN, 2015).

Box-Jenkins models are divided into three (BOX et al., 2016):

1- Stationary linear stochastic models (ARMA),

2- Non-stationary linear stochastic models (ARIMA), and

3- Seasonal models (SARMA).

When non-seasonal models are non-stationary, they are denoted as ARIMA (p, d, q), and when they are stationary (since d=0), the model is expressed as ARIMA (p, 0, q) or ARMA (p, q).

In ARIMA, p is the degree of the autoregression model (AR), d is the degree of differencing, and q is the degree of the moving average model (MA) (MECH, 2017; YILDIRIM & ALKAN, 2018). If there is white noise in the series, it shows that the model is stationary, and estimates are made as

ARMA (p,q) without lags (SAS, 2014). In its simplest form, the stationary series depends on the fact that the mean and variance of the series show a similar change, that they do not show periodic fluctuations. To clarify it more, the evaluated mean and acting of a stationary series ought to be steady, and its covariance should depend on the number of slacks. These conditions are expressed as follows (BOZKURT, 2013; DILLI, 2020; TEKE & ORHAN, 2021).

Forecasting is used to foresee something that will happen soon. In this way, choice predictors can take the suited success with near forecast (BISGAARD & KULAHCI, 2011). If the predictions are more accurate, better decisions can be made in the businesses at a micro-level and countries at a macro level (ERGUN &SAHIN, 2017).

We estimated the chicken meat production quantity for the 2019-2025 periods, based on 58 years of chicken meat production data between 1961 and 2018 with the help of the ARIMA model. In addition, we calculated the production per capita increases in the coming years by comparing the chicken meat production of the leading countries and the world for the 2012-2018 and 2019-2025 periods.

MATERIALS AND METHODS

Materials

The first data of the study, including production and export of chicken meat, the population of countries, and population estimations, were obtained from the database of the FAO of the United Nations. In addition to these secondary data, topics, such as the production, consumption, export, and import of chicken meat, the effects of chicken meat on human nutrition, the cost of feed given to animals produced for meat, the influences of animal manure on the environment, and future forecasting methods, were searched in domestic and foreign internet resources, papers, reports, articles and theses.

Methods

The chicken meat production values of leader countries were estimated in the 2019 and 2025 periods by running the production data in the 1961 and 2018 periods by the ARIMA model in the present study. This model was established with the help of the SAS 9.4 statistical software. The typicality of the data was confirmed by the Shapiro-Wilk test.

The ARIMA model

Mean; $(Y) = \mu$ (expected value does not show a time-dependent variance),

Variance; $(Y_t) = (Y_t - \mu)^2 = \sigma^2$,

Covariance; Cov (Y_t, X_{t+k}) covariance is only a function of k and is shown as

$(k) = [(Y_t - \mu)(Y_{t-k} - \mu)]$.

In cases where white noiseis not WN (0, σ^2), the Dickey-Fuller test is used to determine a unit root test in the series that the series is not stationary. Thus, periodic differencing processes are used in the primary, secondary, or tertiary periods for stationarity data (UZUNDUMLU et al., 2018; DILLI, 2020).

$$y_t = a_0 + a_1 y_{t-1} + a_2 y_{t-2} + \ldots + a_p y_{t-p} + \varepsilon_t \quad (1)$$

where y_t = the value to be forecast at time t,

$y_{(t-p)}$: shows the variable values at different lag times:

y_{t-1}= value realized one step before time t,

y_{t-2}= value realized two steps before time t,

y_{t-3}= value realized three steps before time t,

a_0, a_1, … … . . a_p: Coefficients of AR model,

ε_t: shows the sum of error values

Before proceeding to the ARIMA model operation, three-year lag values were added to the data and analyze

d on Excel by listing the numbers in ascending order on additional columns next to the time series, including t_0, t_1, t_2, and t_3, with blank rows as many as lag years from the first row on t_1, t_2, and t_3, columns.

KADILAR (2009) expressed the ARIMA model as in the following formula;

$$(1-a_1B^1-a_2B^2\ldots-a_pB^p)*(1-B)^d y_t=(1-\theta_1B^1-\theta_2B^2-\ldots-\theta_qB^q)\varepsilon_t \quad (2)$$

where term $(1 - B)^d$t is differencing operation of d^{th} degree, and the $(1 - B)^d y_t$ expression can be written as $By_t = y_{t-1}$ for d=1. Also, d=2 can be written as $B^2 y_t = y_{t-2}$ or $B^1 y_{t-1} = y_{t-2}$.

Before ARIMA modeling, it is ensured that there are no outliers or missing observations in the data and that the data have a normal distribution. In the next step, the model is established after determining whether the data were stationary or not (HASMIDA, 2009).

Alternative estimation models included SCAN and ESACF trial order criteria tests, and p, d, and q values are given in the ARIMA model. The model that meets the most criteria is evaluated as the most appropriate model by taking into account results. These criteria are BIC (Bayesian Information Criterion), SSE (Sum of Squared Estimate of Errors), MSE (Mean Squared Error), SBC (Schwarz's Bayesian Criterion), MAE (Mean Absolute Error), MAPE (Mean Absolute Percentage Error), DW (Durbin Watson Test), RMSEA (Root-mean-square error of approximation), AIC (Akaike Information Criterion), HQC (Hannan-Quinn Criterion) and R^2 (Coefficient of Determination).

RESULTS AND DISCUSSION

Differences between realized and estimated values

Table 1 presents the deviations between the realized and the ARIMA model estimation of chicken meat production of the ten leading countries, the total of other producing countries, and the worldwide for the period between 1962 and 2018.

As shown in table 1, while the ARIMA (1,1,1) model is the most suitable model for the world, other countries, and Turkey, the most convenient models for the rest of the countries were as follows: ARIMA (1,1,4) for Brazil; ARIMA (0,1,4) for Mexico; ARIMA (2,1,1) for Japan; ARIMA (2,1,3) for the USA; ARIMA (3,1,0) for Indonesia, Russia, and Iran; ARIMA (4,1,2) for India; and ARIMA (5,1,0) for China. Regarding chicken meat production in the literature, ARIMA (0,1,1) model was used by RAGABAND AL-SAID (2015) for Egypt, HUSSAIN et al. (2021) for Iraq, and ALDERINY et al. (2020) for Saudi Arabia. Also, ADEKOLA & OLATAYO (2019) used ARIMA (2,1,2) for Nigeria, NIMBALKAR et al. (2019) used ARIMA (0,0,2) for India, and TITUS et al. (2021) used the ARIMA (1,1,1) model for Kenya.

Approximately half of the world's chicken production is provided by the USA, China, Brazil, and Russia. When the realized values and ARIMA models have compared, the prediction of Indonesia and Japan were close to perfection. The highest deviations were in Russia with 1.84% and Turkey with 1.11%. In general, estimated values were lower than the realized values, and there were too small differences between the actualized and estimated values.

Comparison of the world shares of the ten leading countries in the world's chicken meat production by periods

In table 2 below, the chicken meat production values for the 1961-2018 period by the ten leading countries, the total of other producing countries, the world total, and the share of the estimated values in the world for the period between 2019 and 2025 are compared.

As seen in table 2 above, while the total share of the ten countries in chicken meat production was 57.05% in the 1961-2018 period, their whole share between 2019 and 2025 increased to 58.91%. While the highest increase was provided by Brazil with 3.17% and Russia with 1.95%, the highest decrease was expected to occur in the USA with 5.57% and Japan with 0.66%. It was estimated that there would be an increase of 1.86% in the total production of the ten countries in the same period. The share of the three countries (the USA, China, and Brazil) would decrease from 43.25% to 40.97%. According to FAO (2021) data, 118 million tons of chicken meat was produced worldwide in 2019, 16.9 million tons of this production was exported, the strongest exporting countries were Brazil, the USA, and the Netherlands, and these three countries made up half of the world's export.

Comparison of the average chicken meat production of the leading chicken meat producing countries for the periods between 1961-2018 and 2019-2025

Table 3 shows the percentage changes in chicken meat production of the leading chicken

Table 1 - Deviations between the realized and the ARIMA model estimation of average chicken meat production for the 1962-2018 period.

Countries	Model	Realized (thousand tons) (A)	Estimation (thousand tons) (B)	Deviation (%) (100*(B-A)/A)
USA	2,1,3	9,874.43	9,864.80	-0.10
China	5,1,0	5,320.92	5,303.24	-0.33
Brazil	1,1,4	4,478.95	4,471.49	-0.17
Russia	3,1,0	2,037.34	1,999.87	-1.84
India	4,1,2	879.47	873.79	-0.65
Mexico	0,1,4	1,240.31	1,238.64	-0.13
Indonesia	3,1,0	713.17	713.19	0.00
Japan	2,1,1	1,150.36	1,150.33	0.00
Iran	3,1,0	706.00	703.82	-0.31
Turkey	1,1,1	613.82	606.98	-1.11
Others countries	1,1,1	19,550.60	19,476.52	-0.38
World total	1,1,1	45,481.56	45,364.04	-0.26

Note: The 1992-2018 data were used for Russia.

Table 2 - The shares of the ten leading chicken meat producing countries in world chicken meat production and the differences between the two periods (%).

Countries	A (1961-2018)	B (2019-2025)	Difference (B-A)
USA	21.75	16.18	-5.57
China	11.68	11.79	0.11
Brazil	9.82	13.00	3.17
Russia	2.09	4.04	1.95
India	1.93	3.30	1.37
Mexico	2.72	2.85	0.12
Indonesia	1.63	2.11	0.55
Japan	2.53	1.87	-0.66
Iran	1.55	1.84	0.29
Turkey	1.35	1.94	0.60
The share of the ten countries in total	57.05	58.91	1.86

meat producing countries in the 2019-2025 period compared to the 1961-2018 period.

While the world annual chicken meat production average was 45.93 million tons in the 1961-2018 period, it will be 128.51 million tons between 2019 and 2025. World production will reach 139.19 million tons in 2025. The annual increase between 1961 and 2018 was 5%, and it will be around 3.3% in the six years between 2018 and 2025. Compared to the 1961-2018 period, chicken meat production will increase by an average of 179.96% in the 2019-2025 period, with the highest increase in Indonesia by 417.22%, India by 389.37%, and Turkey by 313.21%. RITCHIE & ROSER (2020) commented that the production of poultry meat increased approximately growing 12-fold between 1961 and 2014 worldwide. Thus, total poultry meat production has been growing much faster than the rate of population growth. OSADCHUK et al. (2020) explained that poultry meat consumption per capita increased by 97.6% between 1995 and 2015 and is predicted to rise 5.2% between 2015 and 2025 worldwide.POULTRYMED (2020) estimated world chicken meat production for 2019 as 97.81 million tons. The world's chicken meat production estimates for 2019 and 2020 were 117.83 and 121.39 million tons, respectively, in this study. One hundred eighteen million tons of chicken meat were produced in the world in 2019 is significant for the consistency of the estimates.

Seventeen percent of 20.15 million tons of chicken meat produced in the US in 2019 was

Table 3 - Comparison of chicken meat production of the ten countries between the periods (000 tons).

Countries	Model	1961-2018 (A)	2019-2025 (B)	Change 100*(B-A)/A
USA	2,1,3	9,749.14	20,787.25	113.22
China	5,1,0	5,237.58	15,155.35	189.36
Brazil	1,1,4	4,403.84	16,701.71	279.25
Russia	3,1,0	2,012.99	5,190.26	157.84
India	4,1,2	865.50	4,235.46	389.37
Mexico	0,1,4	1,220.91	3,660.43	199.81
Indonesia	3,1,0	732.51	3,788.73	417.22
Japan	2,1,1	1,132.81	2,398.04	111.69
Iran	3,1,0	694.49	2,363.03	240.25
Turkey	1,1,1	604.27	2,496.93	313.21
Others countries	1,1,1	19,280.28	49,747.07	158.02
World Total	1,1,1	45,903.58	128,509.48	179.96

exported to countries, such as Mexico, Hong Kong, Cuba, Taiwan, Vietnam, Angola, Chile, and Canada (FAO, 2021). The USDA (2020) and STATISTA (2021) estimated that the US would produce 20.50 and 20.26 million tons of broiler meat in 2020, respectively. In the present study, chicken meat production in the US was estimated at 19.91 million tons for 2019 and 20.23 million tons for 2020 using the ARIMA model.

Thirty percent of 13.52 million tons of chicken meat produced in Brazil in 2019 was exported to countries, such as China, Saudi Arabia, Japan, United Arab Emirates, South Africa, and Hong Kong (FAO, 2021). According to the USDA (2020) and STATISTA (2021), chicken meat production in Brazil was estimated to be 13.98 and 13.88 million tons in 2020, respectively. NÄÄS et al. (2015) stated that Brazil was one of the world's leading broiler-producing countries and the biggest broiler meat exporter between 2000 and 2010 for a long time. Unless a surprising occasion happens during the future universal competition, Brazil will presumably increase its production. Chicken meat production in Brazil was estimated at 15.48 and 15.92 million tons for 2019 and 2020 using the ARIMA model in this study.

China ranks third place among chicken meat-producing countries worldwide. While 5.1% of the 15.15 million tons of chicken meat produced in China in 2019 was exported to countries, such as Japan, Hong Kong, Netherlands, Korea, Malaysia, Mongolia, and England, 5.2% of the production was imported from Brazil, Argentina, Thailand, Russia, and Chile (FAO, 2021). The USDA (2020) emphasized that chicken meat production in China would reach 15 million tons in 2020. POULTRYMED (2020) reported that the production quantity in China was 13.75 and 14.85 million tons for 2019 and 2020, respectively. However, in this study, the production of China for 2019 and 2020 was estimated to be 14.35 and 14.33 million tons, respectively.

In 2019, while 4.7% of 4.61 million tons of chicken meat in Russia was exported to countries, such as Vietnam, China, Ukraine, Kazakhstan, Saudi Arabia, Kyrgyzstan, Tajikistan, and Azerbaijan, 4.9% of the production was imported from Belarus, Brazil, and Argentina (FAO, 2021). KOSTENKO (2020) determined that since more than half of the poultry in Russia is concentrated in 12 regions towards the European coast, the number of inhabitants in the area has multiplied between 2004 and 2017. This region specializing in poultry meat production has an extraordinary effect on increasing chicken meat in Russia. The increase in the level of professionalism of poultry production in Russia will also be reflected in chicken meat production in the coming years. Also, SVINUKHOV et al. (2018) explained that Russia is an important chicken producer worldwide. It has an important place, especially in white wheat production. The contributes to the country in reducing input costs with the use of white wheat in chicken production. Also, it extended its export quantity by securing its producers with a tax approach applying to import. According to the USDA (2020), chicken meat production in Russia would be 4.78 million tons in 2019, and the export-import difference would decrease to almost 20 million tons. Cherkizovo, the Russian leading chicken producer, reported an 11% drop in the kg price of all chicken products as consumer purchasing power decreased. Despite extreme-downward pressure on producer margins, Russian chicken meat production was expected to increase moderately in 2019. Accordingly, it was emphasized that the profitability of the Russian poultry sector depended on domestic demand and domestic macroeconomic conditions. In the present study, it was forecast that Russia's production would be 4.69 and 5.00 million tons for 2019 and 2020, respectively, and the average for the period between 2019 and 2025 would be 5.19 million tons.

India produced 4.19 million tons of chicken meat and 0.13% of this production was exported to very few countries, such as Vietnam, Bhutan, Bahrain, Thailand, Maldives, and Myanmar, for 2019 (FAO, 2021). According to the USDA (2020), due to the growing middle-class demand in India, chicken meat production was expected to increase by about 5% and reach 5.1 million tons in 2019. In addition, the increase in the demand for processed chicken meat was expected to grow this sector by 15-20% annually. UTKARSHA et al. (2018) stated that the poultry segment, one of the sub-branches of the agricultural component, drew attention as the fastest developing division of agriculture in India. Also, it is currently the second-fastest-growing market worldwide after Indonesia. Chicken meat production in 1961-2018 was observed to almost quadruple in 2019-2025 in India. It was estimated that the chicken meat production of India would be 3.84 and 3.90 million tons for 2019 and 2020, respectively, and that the average for 2019-2025 would be 4.24 million tons.

In Mexico, 0.13% of 3.48 million tons of chicken meat produced in 2019 was exported as processed chicken meat to the United States and Venezuela, and approximately 25.3% of Mexico chicken meat production was imported from the USA, Brazil, Chile, Canada, and Argentina (FAO,

2021). Chicken meat imports of Mexico increased because of the current market supply exhibiting an inverse and inelastic behavior. The price elasticity of the chicken meat supply non-imports was nonflexible, but with imports, it became flexible in the region. In addition, domestic producers, which increased their technological progress to compete with imports, contributed to an increase in feed efficiency and national supply (REBOLLAR- REBOLLAR et al., 2020). According to the USDA (2020), there was a continuous increase in domestic poultry production in Mexico due to the increased demand for poultry meat and eggs. Chicken meat production was estimated at 3.6 and 3.7 million tons for 2019 and 2020 for Mexico. In this study, it was predicted that the chicken meat production of Mexico would reach 3.4 million tons in 2019 and 3.5 million tons in 2020 and that the average for the 2019-2025 period would be 3.66 million tons.

Indonesia exported 0.011% of 3.50 million tons of chicken meat production in 2019 to mostly East Timor and imported much of the 0.008% of its production as processed chicken meat from the USA (FAO, 2021). TENRISANNA & KASIM (2020) determined an increase in meat-type, such as chicken, beef and pork, between 1990 and years according to 2018 in Indonesia. In addition, they determined that poultry meat production in Indonesia increased from 0.5 million tons to 2.4 million tons in this period, and they predicted 3.30 million tons of production for 2027. 3.51 and 3.74 million tons of production were estimated for 2019 and 2020, respectively, while the annual chicken meat production average for the 2019-2025 period was estimated to be 3.89 million tons. Also, when the 1961-2018 and 2019-2025 periods are compared, chicken meat production in Indonesia will increase more than four times. Indonesia, one of the fastest-growing countries in poultry production, will be the world's sixth-largest producer in the future.

In 2019, Japan exported 0.4% of 2.30 million tons of chicken meat production to Hong Kong, Cambodia, and Vietnam and imported 47% of its total production from Brazil, Thailand, China, and the USA. The ratio of processed and unprocessed chicken meat in chicken imports was 50% (FAO, 2021). Schrager (2018) stated that in the mid-1950s, Japan expanded its grain imports from the United States, which allowed chicken producers to purchase feed as a non-farm input, and that in the early 1960s, Japan imported the latest chicken breeds for egg and meat production from the United States. These breeds were spread rapidly to the country. In the 1960s, Japan came to the fore in world chicken production by having a bash to increase the number of chickens from 300 to 1000 heads in chicken farms. According to the USDA (2020), Japan is thought to continue to grow in this sector steadily in 2018 and 2019, as the Japanese chicken meat sector increased the productivity of large producers in recent years. It is expected that Japanese consumers move from fish to chicken as a more affordable protein (BAO, 2020), chicken consumption is expected to increase rapidly. It was estimated that Japanese chicken meat production would increase by 2% and reach 1.69 million tons in 2018 and 1.73 million tons in 2019. Japanese chicken meat imports were expected to reach 1.1 million tons in 2019 since Thailand continues to reinforce its market position after overtaking Brazil as Japan's largest poultry supplier in 2017. It was predicted that chicken meat production in Japan would be 2.29 and 2.32 million tons in 2019 and 2020, respectively, and that the average would be 2.40 million tons for 2019-2025 in this study.

Iran exported 2.4% of 2.28 million tons of chicken meat to countries, such as China, Vietnam, Iraq, Taiwan, and Thailand, in 2019 (FAO, 2021). As in November 2020, exports may be banned in some periods to meet domestic demand. In this context, Chicken meat is primarily utilized as a source of animal protein within the nutrition of the Iran population since it makes up roughly 60% of meat utilization per capita. With the increase in household incomes and modernization in the last decade, chicken consumption per capita increased from 5.1 kg in 1977 to 26 kg in 2016 (IRAN MINISTRY OF AGRICULTURE, 2017; ZAMANI et al., 2019). In addition, BAHADORIet al. (2018) provided input-output data in the 1990-2014 period from the Iran Ministry of Agriculture and estimated input and outputs the value in 2015-2020 with the ARIMA model. As a result, they estimated that a one-unit increase in corn and soybean prices would increase the chicken meat production in Iran by 7.59% and 3.29%, respectively. The chicken meat production in Iran would be 2.24 and 2.28 million tons in 2019 and 2020, respectively, and that the average chicken meat production for the 2019-2025 period would be 2.36 million tons. Thus, when it is considered that all chicken production per capita in Iran is consumed in the domestic market, the chicken meat consumption per capita will be around 27 kilograms.

Turkey exported 23.8% of 2.14 million tons of chicken meat production to more than a hundred countries, including Iraq, Libya, Hong Kong, United Arab Emirates, and Congo for 2019. The quantity exported to Iraq alone accounted for 55.3%

of this export. Turkey imports 2.1% of its chicken meat production from the USA, Brazil, and Ukraine, and the share of the import from the USA is 65.7% (FAO, 2021). USDA (2020) estimated that chicken meat production in Turkey would increase by 2% in 2020 and reach 2.2 million tons. The Turkish poultry industry is dependent on foreign suppliers for feed, which is the main input cost of poultry businesses. In 2020, out-of-home chicken meat consumption was expected to decrease, but general consumption was expected to increase slightly due to growing household consumption. In 2020, it was expected that chicken meat production in Turkey would reach 2.2 million tons, and its export would reach 0.42 million tons. Using 1961-2015 production data and 1981-2015 export data for Turkey, CICEKGIL &YAZICI (2016) predicted that chicken meat production would be 2.0 million tons in 2016 and 2.6 million tons in 2020, and chicken meat exports would be 0.85 million tons in 2020. Mustafa (2018) estimated the demand for chicken meat as 2.34 million tons for 2019 and 2.46 million tons for 2020. It was predicted that the chicken meat production would be 2.24 and 2.33 million tons for 2019 and 2020, and the annual average for the 2019-2025 period would be 2.50 million tons in the present study.

Comparison of per capita chicken meat production of the world and leading countries for certain periods

Table 4 shows per capita and total chicken meat production of the world and the leading countries in the 2019-2025 period compared to the 2012-2018 and 1961-2018 period.

The world's chicken production was 7.56 million tons in 1961. 34.5, 6.4, 1.7, 1,6, 1.5, 0.9, 0.8, 0.7, and 0.5 percent of this production was obtained by the USA, China, Japan, Brazil, Mexico, India, Turkey, Indonesia, and Iran, with the share of the nine countries being 48.8% in total. The world chicken production was 39.88 million tons in 1992, and 24.5% of this production was covered the USA, 9.0% by China, 7.2% by Brazil, 3.5% by Russia, 3.4% by Japan, 3.1% by India, 2.3% by Mexico, 1.6% by Indonesia, 1.3% by Iran, and 1.1% by Turkey. The share of the ten countries was 55.2% in total.

The world's chicken production was 114.27 million tons in 2018. 17.1, 13.1, 12.8, 4.0, 3.1, 3.0, 2.9, 2.0, 1.9, and 1.1 percent of this production was met by the USA, Brazil, China, Russia, India, Indonesia, Japan, 1.9% by Iran and Turkey, with the share of the ten countries being 61.7% in total.

Compared to the 2012-2018, the world chicken meat production rate in the 2019-2025 will decrease from 17.6% to 16.2% in the USA, from 13.0% to 11.8% in China, from 2.9% to 2.8% in Mexico, from 2.0% to 1.9% in Japan, and from 2.0% to 1.8% in Iran, while it will increase from 13.0% to 16.7% in Brazil, from 3.9% to 4.0% in Russia, from 3.1% to 3.3% in India, from 2.2% to 3.0% in Indonesia, and from 1.9% to 2.0% in Turkey. The production estimates of the leading countries in chicken production in 2019-2025 period will be higher than the chicken meat production they achieved in 2012-2018. However, when the same periods are considered, the total share of the ten countries in world chicken production will decrease from 61.0% to 60.0%. This shows that apart from these 10 countries, Argentina, Poland and South Africa will emerge as countries with a rapid increase in production.

While the world population increased from 3.1 billion people in 1961 to 7.6 billion people in 2018, with a 145% increase, chicken meat production increased from 7.6 million tons to 114.3 million tons, with an approximately 1404% increase. Compared to 1961 and 2018, the population increased by 2.5 times, and chicken meat production increased by 15 times, with chicken production increasing six times faster than the human population. In the same period, chicken production per capita in the world increased from 2.4 kilograms to 16.2 kilograms, which accounted for approximately an increase of 6.5 times. When world chicken production quantities per capita are compared by periods, while the annual production per capita was 8.5 kg in the 1961-2018 period, it increased to 14.7 kg between 2012 and 2018, and chicken meat production per capita will increase to 16.2 kg between 2019 and 2025. According to MOEKTI (2020), with the development of animal production in many parts of the world, industrialized large-scale production of high-yield livestock products has caused 70% of rural residents to live in urban areas and earn a better income. Global chicken meat production is growing faster than other types of meat due to a higher consumer preference for chicken meat than the apart from types of meat. ALEXANDRATOS & BRUINSMA (2012) stated that chicken meat production increased rapidly in recent years and that the annual growth rate in the last 50 years was 5%, with this increase occurring 3.1% in pork, 1.7% in sheep-goat meat, and 1.5% in beef.

Considering the countries, chicken meat production per capita was higher than the world average only in Mexico, out of eight countries other than the USA, which dominated the world chicken production in 1961. In 2018, chicken production per capita in China, India, and Indonesia, the leading countries in chicken production, was below the world average. With 13.8 kg chicken production per

Table 4 - Comparison of per capita chicken meat production of the world and the ten leading countries.

Countries	Variables	1961	2018	1961-2018	2012-2018	2019-2025
World	A	7,555.9	114,266.8	44,827.7	103,866.4	128,509.5
	B	3,091.8	7,631.1	5,295.8	7,045.6	7,932.7
	C	2.4	15.0	8.5	14.7	16.2
USA	A	2,607.7	19,568.0	9,749.1	18,283.0	20,787.3
	B	189.6	327.1	255.8	311.5	334.7
	C	13.8	59.8	38.1	58.7	62.1
Brazil	A	122.8	14,914.6	4,403.8	12,987.1	16,701.7
	B	74.3	209.5	145.3	197.0	215.2
	C	1.7	71.2	30.3	65.9	77.6
China	A	487.1	14,578.7	5,237.6	13,501.8	15,155.4
	B	685.5	1,459.4	1,155.8	1,402.5	1,485.8
	C	0.7	10.0	4.5	9.6	10.2
India	A	69.0	3,590.5	865.5	3,176.8	4,235.5
	B	459.6	1,352.6	883.9	1,242.8	1,411.8
	C	0.2	2.7	1.0	2.6	3.0
Mexico	A	115.0	3,338.4	1,220.9	3,009.9	3,660.4
	B	39.0	126.2	82.2	116.9	131.7
	C	3.0	26.5	14.9	25.8	27.8
Indonesia	A	52.0	3,409.6	732.5	2,346.8	3,887.7
	B	90.1	267.7	177.4	248.1	279.9
	C	0.6	12.7	4.1	9.5	13.9
Japan	A	132.0	2,250.3	1,132.8	2,061.9	2,398.0
	B	94.6	127.2	118.7	126.8	125.6
	C	1.4	17.7	9.5	16.3	19.1
Iran	A	38.5	2,187.1	694.5	2,046.0	2,363.0
	B	22.5	81.8	51.1	74.8	85.9
	C	1.7	26.7	13.6	27.3	27.5
Turkey	A	60.0	2,156.7	604.3	1,922.7	2,496.9
	B	28.1	82.3	52.4	74.4	85.2
	C	2.1	26.2	11.5	25.9	29.3
Russia	A	1,379.9	4,543.0	2,013.0	3,990.1	5,190.3
	B	148.3	145.7	145.4	145.0	145.8
	C	9.3	31.2	13.8	27.5	35.6

Note 1: The data for Russia covered years starting from 1992.
Note 2: A=Chicken meat production (thousand tons), B=Population (million people), C=Per capita chicken meat production (kg).

capita, the USA was unquestionably the number one in 1961, whereas in 2018, Brazil, which made significant progress, ranked first place with 71.2 kg, the USA was the second with 59.8 kg, and Russia was the third with 31.2 kg. Also, according to RITCHIE & ROSER (2020), chicken consumption of leading countries per capita was 55.68 kg in the US, 48.03 kg in Brazil, 32.52 kg in Mexico, 27.52 kg in Iran, 26.67 kg in Russia, 20.64 kg in Turkey, 18.50 kg in Japan, 12.88 kg in China, 7.19 kg in Indonesia, and 2.22 kg in India. When nation rankings are taken under consideration, there is, for the most, part no difference between chicken meat generation per capita and chicken meat utilization per capita. Considering 2012-2018 and 2019-2025, chicken production per capita will increase in the leading countries worldwide. Due to the recession caused by COVID-19, chicken meat was preferred as a substitute for beef and pork. The highest increase between the two periods will be observed in Indonesia with 31.7%, Russia with 22.8%, Brazil with 15.1%, Japan with 14.7%, India with 13.3%, Turkey with 11.6%, Mexico with 7.2%, China with 5.9%, the US with 5.5%, and Iran with 0.7%.

CONCLUSIONS

This study was carried out to predict chicken meat production from 2019 to 2025 for the leading chicken-producing countries including 1961-2018 FAO data. The USA is the largest producer, and Brazil and China are the second and third in chicken meat production, respectively. In light of the findings obtained in this study, while the rate of increase in world chicken production was approximately 5% annually in the 1961-2018 period, it will be around 3% between 2019 and 2025. The findings suggested that production increments will be proceeding to extend at diminishing rates. Indonesia, Russia, Brazil, Japan and India will provide the highest increase in production. In these periods, the share of the ten countries in production will decrease from 61% to 60%. In other words, other countries, such as Argentina, Poland and South Africa, which have made significant progress in production recently, will also have a considerable impact on the market. Because export income increases in meat production per capita, this will lead to an increase in meat consumption per capita providing quality protein intake and good nutrition, especially in underdeveloped and developing countries. Therefore, countries that prioritize chicken meat production or export will develop their strategies in chicken meat markets. The developed countries wanted to benefit from distant markets will increase their costs with more comfortable vehicles to reduce livestock losses or focus on the processed chicken meat industry. The most critical issue of the chicken meat industry is whether buyers are appropriate for modern advertising. Advertising activities to increase chicken meat consumption will be a good factor, especially for new generations. As a kind of recommendation, countries that have developed the chicken meat production industry, reduced costs, achieved quality advantages, and taken entrepreneurial activities forward will be more advantageous in chicken meat.

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DECLARATION OF CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHORS' CONTRIBUTIONS

Both authors were contributed to the writing of the manuscript. MD has contributed to the compilation and preparation of the data. ASU has contributed to making data analyses of this study and submitted the manuscript by making all correspondence and revisions.

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