RESEARCH ARTICLE

Structural Change Analysis of Honey Export Markets of India: Markov Chain Approach

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ABSTRACT

The purpose of this study was to use the Markov chain to predict future honey exports to importing destinations, and analyze honey exports from India to various major import markets. Secondary data, the yearly export of honey from India to other countries were collected from 2013 to 2023.

The results showed that the USA, UAE, and Qatar were stable destinations for Indian honey. At the same time, other importing countries, like Morocco, were unstable (had low retention probabilities) in their export share to these markets. The most unstable importing countries were Saudi Arabia, Libya, and Bangladesh. The predicted export shares of honey to major importing countries revealed that the export share of Indian honey is expected to be highest in the USA and UAE over the next four years.

INTRODUCTION

A naturally occurring substance, honey is a delicious liquid made by honey bees from plant nectar. About 200 different substances, including sugar, protein, enzymes, minerals, vitamins, amino acids, and a variety of polyphenols, are found in honey. The ratio of these components gives each honey its unique color, flavor, viscosity, and medicinal properties (Rao *et al* 2016). The most vital goods produced by bees for human nourishment and health include honey, pollen, royal jelly, propolis, bee wax, venom, and more. According to FAO, the contribution of bees to food security at the global level is about 30% (FAO, 2018). Apiculture, also known as beekeeping, is the cultivation of honeybees, and it is one of the contemporary agro-industries playing a significant role in the agro-economy subsector that guarantees employment for a significant number of farmers, extra revenue for farmers and bee enthusiasts, a better standard of living and contributing to the increase in agricultural production value, which further boosts the contribution of agriculture to global GDP and economic prosperity.

Honey has been used for food and medicinal purposes for decades. Ancient Indian communities living in forests and rock shelters were among the first to use this natural sweetener, thus contributing to India's long history in honey and beekeeping (Chanie *et al*, 2019 and Hando *et al*, 2023). India, often referred to as the 'land of honey has enormous potential for producing honey because of its diverse flora, which includes more than 500 species that are both cultivated and wild and are excellent suppliers of pollen and nectar (Kumar *et al*, 2024). In addition to many stingless bee species, the nation is home to five kinds of real honey bees: Apis dorsata, Apis mellifera, Apis dorsata, Apis laboriosa, Apis cerana indica, and Apis florae (IMARC ,2023 and Vahoniya *et al*, 2023).

Major honey producing states in the country include Punjab, Haryana, Himachal Pradesh, UP, Bihar and West Bengal (Shilpashree *et al*., 2017). More than 85% of India's total honey exports go to the American and Asian continents, and the country ranks third in the world for honey exports (APEDA, 2024). According to statistics, global honey output reached 1.77 million metric tons in 2021, which was 41% higher than in 2000 (1.25 million MT) and 5.4% lower than the peak in 2017 (1.87 million MT). (Statista, 2023). China, New Zealand, India, Argentina, Ukraine, Spain, Germany, Brazil, Belgium, and Hungary were the top

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10 honey exporting nations in the world in 2023.In the same year, the top 10 importing countries were USA, Germany, Japan, France, UK, Belgium, Italy, Spain, China and Poland. The list was ranked descending by the quantity exported and imported as shown in Fig 1 and Fig 2.

Fig 1: Honey export value in the top 10 exporting countries worldwide in 2023 (USD thousand)
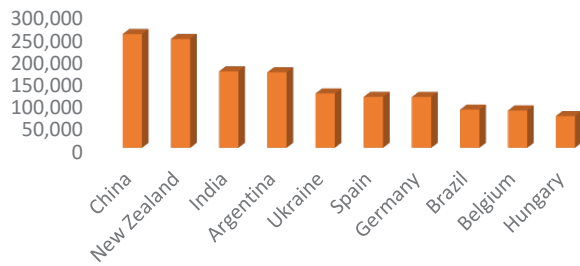
Fig 2: Honey import value in the top 10 importing countries worldwide in 2023 (USD thousand)
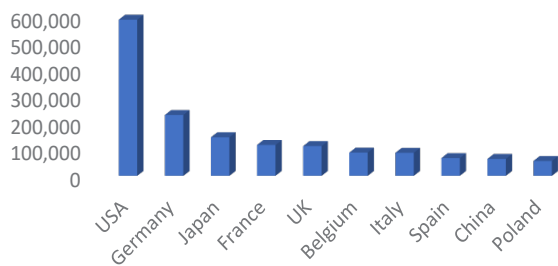
METHODS AND MATERIALS

The study is entirely based on secondary data and the study period is 2013 to 2023. The data were collected from ITC trade map.

Markov chain analysis

Markov chain analysis was employed to analyze the structural change in any system whose progress through time can be measured in terms of a single outcome variable (Dent, 1967). In the present study, the dynamic nature of trade patterns that is, the gains and losses in the export of Indian honey in major importing countries, was examined using the Markov chain model. Markov chain analysis involves developing a transitional probability matrix 'P whose elements, P_{ij} indicate the probability of exports switching from the country 'i' to the country 'j' over time. The diagonal element P_{ij} where i=j, measures the probability of a country retaining its market share or in other words, the loyalty of an importing country to a particular country's exports (Yogesh and Srivastava, 2020). In the context of the current application, there were seven major importing countries for Indian honey, viz USA, UAE, Saudi Arabia, Libya, Qatar, Morocco and Bangladesh and all other countries grouped under others. The assumption was that the average export of honey from India amongst importing countries in any period depended only on the exports in the previous period, and this dependence was the same among all the periods (Mahadevaiah *et al.*, 2005). This was algebraically expressed as

$$E_{jt} = \sum_{i=1}^{r} E_{it} - 1P_{ij} + e_{jt}$$

where,

E_{jt} = Exports from India to the ith country during the year t

E_{it-1} = Exports to the ith country during the year t – 1

P_{ij} = Probability that exports will shift from the ith country to j^{th} country

e_{jt} = Error-term which is statistically independent of $e_{jt}-1$, and

r = Number of importing countries.

The transitional probabilities P_{ij}, which can be arranged in a (c × r) matrix, had the following properties (Satish and Babu, 2017).

1) $0 \leq P_{ij} \leq 1$

2) $\sum_{i=1} P_{ij} = 1$ for all i

The expected export-share of India during a particular period, t, was obtained by multiplying the quantity of exports to the selected seven during the previous period (t–1) with the estimated transition probability matrix (P) (Mohandas and Kuruvila, 2018). The transition probability matrix was estimated in the linear programming (LP) framework by a method referred to as the minimization of Mean Absolute Deviation (MAD) (Joshi *et al.*, 2015). The probability matrix was estimated for the period 2013 to 2023. The LP formulation on analysis was stated as:

MinOP* + Ie
Subject to,
XP* + V = Y
GP* = 1
P* ≥ 0

where,

P* is a vector of the probabilities P^{ij}

O is the vector of zeros

i is an appropriately dimensional vectors of areas

e is the vector of absolute errors

Y is the proportion of exports to each country.

X is a block diagonal matrix of lagged values of Y

V is the vector of errors

G is a grouping matrix to add the row elements of P arranged in P* to unity.

Forecasting of export scenario

Prediction of quantity of honey export share was made by using the Transitional Probability Matrix (Siddeshwar *et al.*, 2017).

$$B_t = B^*_o T$$

$$B_{t+i} = Bt+i-1^* T$$

where,

B_o = Quantity exported in Base years,
B_{t+i} = Quantity exported in next year (prediction),
T = Transitional probability matrix.

RESULTS AND DISCUSSION

Trade performance of honey in India

Trend in export and import of natural honey in India for a decade was depicted in Fig 3 and Fig 4.

From 2013 to 2023, the export performance of natural honey showed a growing trend, rising from 30099 tons to 98273 tons. As illustrated in Fig. 3, the lowest export was recorded in the year 2014 with 26976 tons, while the greatest export was recorded in the year 2023 with 98273 tons. During 2022, the imports of natural honey reached peak level with 1,138 tons as shown in Fig 4. Throughout the study period, there is fluctuation in the number of honey imports.

Markov chain analysis

Markov chain analysis was applied for annual export data for the period 2013 to 2023. The major seven honey importers from India, i.e., USA, UAE, Saudi Arabia, Libya, Qatar, Morocco and Bangladesh were considered for analysis. The honey trade with the remaining countries was pooled under other countries. The Transitional Probability Matrix (Kusuma and Rudrapur, 2016) presented in Table 1 provides a

Fig. 3. Trend in the export of honey from India (2013-23)
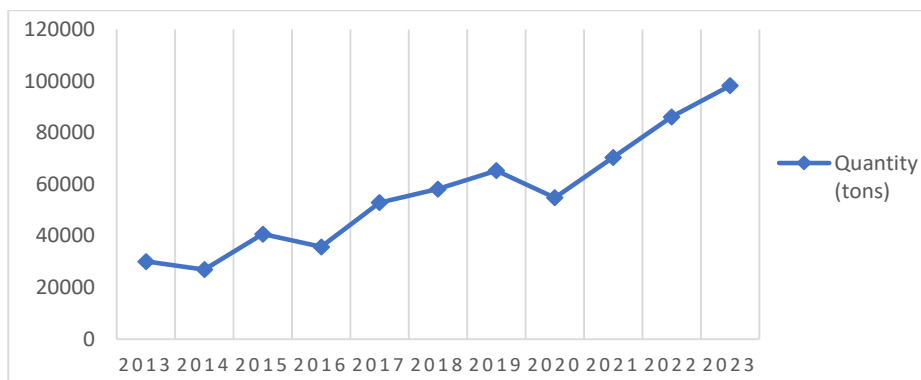
Fig. 4. Trend in import of honey from India (2013-23)
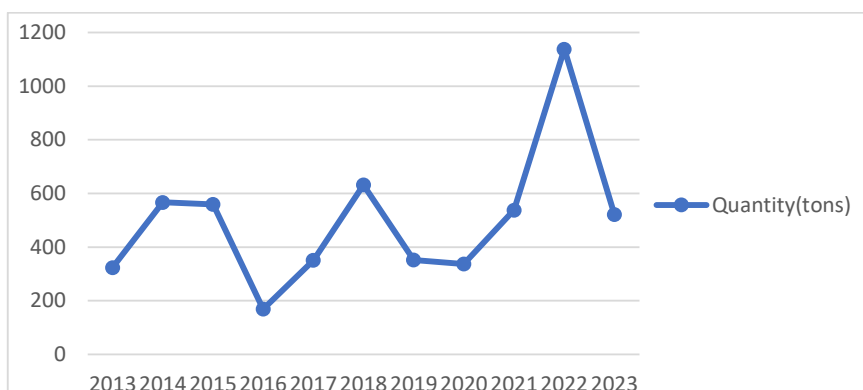
broad indication of changes in the direction of export of honey from India for the study period. The row elements in the transitional probability matrix provide the information on the extent of loss in trade, on account of competing countries. The columns element indicates the probability of gains in volume of trade from other competing countries and the diagonal element indicates a probability of retention of the previous year's trade volume by the respective country (Manjunath et al., 2017).

It is evident from Table 1, USA were the most stable importer of Indian honey as they retained 89.5 per cent of the share from the previous year by losing mainly 6 per cent to others countries, 1.4 to Saudi Arabia. UAE was another stable importer country of honey from India.They retained their original share of 52.1 percent from the previous year by losing 36 percent to the USA and 11.9 percent to Libya. Qatar, Morocco and other countries are unstable (low retention probabilities) export share to these markets. Saudi Arabia, Libya and Bangladesh are the most unstable markets among importing countries of Indian honey during the period as these the countries did not retain any amount of their share from the previous year.

The market share projections of Indian honey exports to the major importing countries were computed using the transitional probability matrix (Shilpa *et al*., 2017). Table 2 presents the actual and predicted values of Indian honey exports to major importers from 2013 to 2023.

The actual share of USA in honey export showed slight decreasing trend over the period 2013 to 2023; it was 83.64 percent to 82.40 percent, also predicted share decrease from 84.64 percent to 81.54 percent (Table 2). There was a slight fluctuation throughout the period in both actual and predicted share. With regard to UAE the actual market share and predicted was shown to increase from 3.34 per cent to 8.27 per cent and 3.20 per cent to 6.24 per cent respectively from over a period. In case of Saudi Arabia, the actual and predicted proportion of market share shown decreasing trend from 6.65 per cent to 1.71 per cent and 2.54 per cent to 2.38 per cent respectively. With regards Libya the actual proportion of market share showed increasing trend from 0.50 per cent to 1.29 per cent and predicted export share 0.76 per cent to 1.35 per cent during the study period shown in Table 2. With respect to Qatar, the actual and predicted proportion of exports showed increasing trend i.e., 0.21 per cent to 0.80 per cent, and 0.54 per cent to 0.72 per cent. In the case of Morocco, the actual proportion of exports showed a slight increase, i.e., 0.89 percent to 0.96 percent, and a predicted decrease from 1.14 percent to 0.97 percent. With regard to Bangladesh the actual and predicted proportion of market share shown decreasing trend from 0.86 per cent to 0.67 per and 1.32 per cent to 1.06 per cent. Concerning other countries, the actual market share and predicted of Indian honey exports shows slight decreasing trend from 3.92 per cent to 3.91 per cent and 5.86 per cent 5.73 per cent respectively.

CONCLUSION

The Markov chain analysis of honey exports from India indicated that the USA, UAE, and Qatar were stable destinations for Indian honey exports, while Morocco and other importing countries were unstable (had low retention probabilities) in their export share to these markets. The most unstable importing countries were Saudi Arabia, Libya, and Bangladesh. The predicted export shares of honey to major importing

Table 1. Transitional probability matrix of Indian honey export during 2013 to 2023

Countries	USA	UAE	Saudi Arabia	Libya	Qatar	Morocco	Bangladesh	Others
USA	0.895	0.005	0.014	0.004	0.004	0.006	0.012	0.060
UAE	0.360	0.521	0.000	0.119	0.000	0.000	0.000	0.000
Saudi Arabia	0.919	0.000	0.000	0.000	0.000	0.032	0.049	0.000
Libya	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Qatar	0.000	0.701	0.000	0.000	0.299	0.000	0.000	0.000
Morocco	0.000	0.992	0.000	0.000	0.000	0.008	0.000	0.000
Bangladesh	0.000	0.000	0.720	0.000	0.000	0.000	0.000	0.280
Others	0.512	0.000	0.195	0.000	0.040	0.109	0.000	0.144

Table 2. Export share of Indian honey to selected countries in (per cent)

	USA		UAE		Saudi Arabia		Libya		Qatar		Morocco		Bangladesh		Others	
Years	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P
2013	83.64	84.64	3.34	3.20	6.65	2.54	0.50	0.76	0.21	0.54	0.89	1.14	0.86	1.32	3.92	5.86
2014	80.51	84.73	2.16	2.71	9.79	2.94	0.90	0.61	0.07	0.49	1.14	1.23	1.46	1.44	3.98	5.85
2015	89.59	84.99	1.98	2.92	2.57	2.72	0.61	0.63	0.30	0.53	1.23	0.87	1.44	1.19	2.29	6.15
2016	84.26	82.80	3.43	3.45	2.72	3.45	0.55	0.78	0.53	0.73	0.87	1.26	1.51	1.14	6.15	6.40
2017	85.33	83.54	3.15	3.11	3.45	3.20	0.27	0.75	0.68	0.74	0.56	1.18	1.42	1.19	5.13	6.30
2018	82.12	82.63	3.11	3.71	3.53	3.21	0.93	0.73	0.74	0.84	1.16	1.43	0.83	1.15	7.58	6.29
2019	83.16	82.23	3.18	4.41	3.21	3.08	0.52	0.74	1.05	0.89	1.61	1.29	0.98	1.15	6.29	6.21
2020	75.59	79.22	4.69	5.70	4.68	4.02	0.85	0.89	1.29	1.05	1.98	1.63	1.61	1.13	9.31	6.36
2021	77.92	80.47	5.70	5.66	4.52	3.32	0.80	1.02	0.92	0.87	1.66	1.42	1.13	1.15	7.36	6.09
2022	81.52	80.92	7.31	6.30	2.00	2.71	1.02	1.23	0.96	0.80	1.42	1.09	0.87	1.07	4.91	5.88
2023	82.40	81.54	8.27	6.24	1.71	2.38	1.29	1.35	0.80	0.72	0.96	0.97	0.67	1.06	3.91	5.73

A-Actual, P- Predict

The export shares of Indian honey were forecasted for four years from 2024 to 2027 and results are presented in Table 3. The export share to USA, Saudi Arabia, Qatar, Morocco, Bangladesh, and other countries shares are expected to rise, whereas, UAE and Libya countries are expected to fall. The projected percent export share of Indian honey to USA has tremendous share around 82 per cent for next forecasted years, other countries and UAE followed next to USA.

Table 3. Forecasted export shares of Indian honey to major importing selected countries

Years	USA	UAE	Saudi Arabia	Libya	Qatar	Morocco	Bangladesh	Others
2024	81.66	5.14	3.01	1.10	0.76	1.19	1.09	6.05
2025	81.86	4.81	3.09	0.97	0.79	1.25	1.12	6.11
2026	81.90	4.71	3.13	0.93	0.80	1.26	1.13	6.14
2027	81.91	4.68	3.14	0.92	0.80	1.26	1.13	6.15

countries revealed that the export share of Indian honey is expected to be highest in the USA and UAE over the next four years. India should not depend too much on these countries in order to lower trade risks over time.

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