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Research Paper

India in the Global Processed Food Arena: A Comparative RCA Analysis against Emerging Economy Peers

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ABSTRACT
Using Revealed Comparative Advantage (RCA) indices, this paper examines the competitiveness of India's processed food exports vis-à-vis five large emerging economy competitors — China, Brazil, Thailand, Viet Nam, and Indonesia — across 87 food processing subsectors during 1995–2023. The analysis uses one-way ANOVA and Kruskal-Wallis tests to analyze the significance of differences between economies. Results confirm significant differences among all pairs of economies ($p < 0.001$). China is ranked first with the highest mean RCA (1.25) and 10. 42.65% categories with RCA > 1.2 India is ranked third in the overall index (mean RCA = 1.06) but has a commanding lead in Minimal Processing (mean RCA = 2.21) and Ingredients (mean RCA = 2.57) – the only economy to be a leader in two processing levels at the same time. India's highest score is in Salt/Sugar Processing (0.39) and Precursor (0.22) areas. A temporal analysis indicates that India's overall competitiveness was highest in 2005–09 (mean RCA = 1.26) and has been slightly declining since, in contrast to the unwavering status of Thailand and the persistent-growth of China.

Keywords: *Revealed Comparative Advantage, India, China, Processed Food Trade, Emerging Economies, Benchmarking, Value Chain*

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I. Introduction

The worldwide processed food market has undergone rapid transformation in the last 30 years as a result of growing incomes in the developing world, changing dietary habits, and new global value chain structures. Emerging economies such as India, China, Brazil, Thailand, Viet Nam, Indonesia, etc. have emerged as key players in global Agro-food exports and are competing in similar product lines. While they matter, there is still limited cross-country comparative work at the disaggregated level on processed food competitiveness. The majority of existing literature either concentrates on a single country or relies on more aggregated trade data, which conceals heterogeneity within sectors. The rise of global Agro-food value chains as the principal organizing mechanism for international food trade has enhanced the extent of competition in the food-exporting country markets. In that context, a group of major emerging economies — India, China, Brazil, Thailand, Viet Nam, and Indonesia — have been raising their stakes in global processed food markets on the basis of different mixes of resource endowments, labor cost advantages, and industrial policy support. Together, these six represent a big chunk of world Agro-food exports and yet they differ significantly in their competitive profiles related to the types of products, processing intensity and orientation to markets. In the case of India in particular, the processed food exports have consistently risen in absolute value to the tune of about USD 38 billion during 2022–23 (Agricultural and Processed Food Products Export Development Authority, APEDA, 2023). But this aggregate progress hides some major compositional fragilities: the basket of Indian exports is still largely dominated by categories that are intact, with only a small relatrue to composite or chemically processed food items of higher value. Benchmarking India’s competitiveness in a peer context is crucial to understand where structural upgrading is possible, where it is undergoing erosion, and where India’s existing advantages are, in fact, sustainable vis-à-vis competitor economies. Comparative analysis of RCA over peer economies precisely offers such benchmarking function. The Balassa RCA concept (Balassa, 1965), further extended by Vollrath's (1991) measures, and by Leromain and Orefice (2014) has the advantage of organizing trade specialization pattern in a manner that allows for comparison across countries without the need to use price or productivity data which are often not available at the detailed product level. Previous comparative investigations - i.e. Jambor and Babu (2016) on global food competitiveness and Huang et al. (2017) on China's Agro-food trade - have revealed substantial inter-country heterogeneity of RCA profiles but have yet to deliver a processing-level contest of India vis-à-vis its main emerging economy rivals guided by formally tested statistical inference.

II. Literature Review and Research gap:

Huang et al. (2017) recorded China's competitive advantage flows for food processing, composite and ingredient products. Brazil has the strongest comparative advantage in the Composite and the raw categories — largely due to soy, meat and sugar industries — though is less so in the processing-intensive areas. Sharma and Shard (2020) analyzed the food export performance of India and China using HS-2 data but did not study heterogeneity at the processing level, an omission which this paper fills. Fermentation and Smoking: Thailand has a strong reputation worldwide for its seafood products, including fermented and smoked seafood, as evidenced by the high RCA values of the country in these two categories. Viet Nam's rapid trade integration since the 2000s has led to an emerging comparative advantage in fresh and fermented agricultural products. Indonesia is competitive only in those areas such as palm oil intermediates and fermented products. There is no study which systematically contrasted India's level of processing RCA with that of several emerging economy contenders using product level information and non-parametric tests.

Need and Significance of the Study

India participates in world markets for processed foods with economies that also possess similar resource endowments and are outward facing — China, Thailand, Brazil, Viet Nam, and Indonesia. But we are not aware of any analysis that systematically compares India's competitiveness with that of these peers at the processing-level based on statistically rigorous methods. As global Agro-food value chains have come to increasingly favor processing sophistication, it has become indispensable to know where exactly India is ahead, behind, or losing ground to competitors from peer economies. This comparative view allows policy-makers to formulate more focused catch-up strategies, take advantage of diplomatic trade negotiations, and shift export promotion funding towards those segments where India's competitive gap is most impactful on long-term value-chain positioning. This paper is the first to integrate processing level RCA disaggregation with formal non parametric statistical testing – ANOVA, Kruskal-Wallis and Mann-Whitney U tests – in a multi-economy comparative framework based on almost three decades of UNCTAD trade data. The surprise that India unequivocally leads all five peers in both Minimal Processing and Ingredients Composites but concurrently is the weakest in competitiveness in the Precursor and Salt / Sugar Processing composites provides a rich multi-sectorial competitive map that cannot be derived from aggregated analysis. This dual imperative – to leverage existing strengths and pursue strategically-selected deficit segments, benchmarked against Thailand and China – can serve as a practical, evidence-based platform for India in its strategy for exports of processed food and for bilateral trade talks.

Objectives

1.To examine the processed food RCA profile of India relative to the RPChina, Brazil, Thailand, Viet Nam and Indonesia for the period 1995–2023 by processing levels.
2.To use analyses of variance, Kruskal–Wallis and Mann–Whitney U tests to test statistically the significance of differences in RCA distributions across countries.

Hypothesis

The competitiveness of processed food exports of India is very different from all other five peer economies at all levels of processing and in all the time periods.

III. Data and Methodology

The analysis evaluates India's competitiveness in processed food exports vis-à-vis five other leading emerging market peers (China, Brazil, Thailand, Viet Nam, and Indonesia) with the help of Revealed Comparative Advantage (RCA) indices that have been extracted from the UNCTAD Statistics database (https://unctad.org/statistics). The period of analysis lies between 1995 and 2023 and is based on 87 disaggregated processed food groups drawn from a global panel of 210 economies, giving rise to 9, 685 economy-category-year information within the context of the six peer economies. Processing stages are based on the A–G system: Raw (A), Minimal Processing (B), Salt/Sugar Processing (C), Fermentation/Smoking (D), Composite (E), Ingredients (F), and Precursor (G). The key strength indicator is the Balassa (1965) RCA index. Firm economy and processing level means, medians, standard deviations and percentages of RCA > 1 observations are used for the inter-economy comparison. The mean RCA in each period is calculated over six sub-periods (from 1995 to 2023) to assess changes over time. The statistical significance of inter-economy RCA differences are tested by three corresponding tests: one-way ANOVA (parametric), the Kruskal-Wallis H-test (non-parametric analog), and pairwise Mann-Whitney U tests between India and each other peer economy. The selection of non-parametric tests is further supported by the Shapiro-Wilk test that established non-normality of RCA distributions ($W = 0.56$, $p < 0.001$).

IV. RESULTS AND DISCUSSION

4.1 Overall RCA Profile: Cross-Economy Comparison

Table 6. Overall RCA Profile of Peer Economies — Processed Food, 1995–2023

Economy	N (obs.)	Mean RCA	Median	Std. Dev.	% RCA > 1	Peer Rank
China	1,763	1.2468	0.7694	1.3134	42.65%	1st
Thailand	1,754	1.0667	0.5329	1.6435	32.67%	2nd
India	1,751	1.0641	0.2839	1.9112	25.36%	3rd
Viet Nam	1,390	1.0519	0.4624	1.4231	31.01%	4th
Indonesia	1,273	0.9915	0.4739	1.6728	17.41%	5th
Brazil	1,754	0.9872	0.4382	2.1515	28.51%	6th

Note: % RCA > 1 = proportion of observations where RCA exceeds unity. Source: Authors' computations.

China tops the list with a mean RCA of 1.25 and 42.65% of observations above unity, indicating the breadth and depth of its processed food export machinery. By mean RCA, Thailand and India are second and third (1.07 and 1.06 respectively), but their competitive profiles, as the composition shows, are very different. The standard deviation in India is also 1.91 which shows the bipolarity of the competitiveness of the country- it is extremely strong in a few categories and very weak in a few others.

4.2 Processing-Level Profiles: India vs. Peers

Table 7. Mean RCA by Economy and Processing Level — Processed Food, 1995–2023

Economy	Raw (A)	Minimal Proc. (B)	Salt/Sugar (C)	Ferment. (D)	Composite (E)	Ingredients (F)	Precursor (G)
Brazil	0.7905	0.9329	0.7838	0.3158	**1.6952**	1.7813	0.4663
China	1.4874	1.2508	**1.0305**	0.7951	1.5977	0.8994	**1.2555**
India	0.9528	**2.2056**	0.3885	0.7550	0.7759	**2.5718**	0.2204
Indonesia	0.6956	1.4354	0.5627	2.1052	0.9913	0.9996	0.5900
Thailand	0.7439	0.9070	0.9917	**2.1173**	1.5420	0.7304	0.4424
Viet Nam	0.7734	1.9298	0.8236	1.2025	0.7977	1.5477	0.5581

Note: Bold values indicate the leading economy within each processing level. Source: Authors' computations.

Only India attained the highest average RCA across two processing levels — Basic Processing (B: 2.21) and Ingredients Processing (F: 2.57). No other peer economy attains above one average RCA in both these levels of aggregation. India holds the minimum or near-minimum average RCA in Salt/Sugar Processing (0.39), Precursor (0.22), and Composite (0.78).

4.3 India's Competitive Position Relative to Best Peer by Level

Table 8. India's RCA Position Relative to Peers by Processing Level

Processing Level	India RCA	Best Performer	Gap	India's Position
Raw (A)	0.9528	China (1.4874)	−0.5346	Below China; competitive with Brazil/Thailand
Minimal Processing (B)	2.2056	India (2.2056)	—	India leads all peers
Salt/Sugar Processing (C)	0.3885	China (1.0305)	−0.6420	Weakest among peers
Fermentation/Smoking (D)	0.7550	Thailand (2.1173)	−1.3623	Substantially below Thailand & Indonesia
Composite (E)	0.7759	Brazil (1.6952)	−0.9193	Well below Brazil and China
Ingredients (F)	2.5718	India (2.5718)	—	India leads all peers convincingly
Precursor (G)	0.2204	China (1.2555)	−1.0351	India weakest; China dominant

India has the largest negative gap in competitiveness in Fermentation/Smoking (−1.36 relative to Thailand) — and it is exactly in this area, where India's resource base (fisheries, dairy) should have provided an advantage. Precursor (gap of –1.04 versus China) and Composite (gap of –0.92 versus Brazil) are the higher-value segments where India's absence in the sector structure is most damaging for its hopes of upgrading in the value-chain.

4.4 Temporal Trends: Convergence or Divergence?

Table 9. Period-wise Mean RCA by Economy — Processed Food, 1995–2023

Economy	1995–99	2000–04	2005–09	2010–14	2015–19	2020–23	Trend
Brazil	1.2273	1.2548	0.8933	0.8393	0.9457	0.7439	↓ Declining
China	1.4285	1.2978	1.1959	1.1821	1.1628	1.2246	↔ Stable
India	1.0706	1.1813	1.2586	0.9766	0.9565	0.9358	↓ Mild decline
Indonesia	—	1.2142	1.1455	0.8885	0.9212	0.9228	↓ Post-peak
Thailand	1.0371	1.0462	1.0572	1.0756	1.0084	1.1986	↔ Resilient
Viet Nam	—	1.3000	1.0015	0.9782	0.9499	1.0533	↔ Recovering

Note: '—' = data unavailable. Source: Authors' computations.

India's competitive advantage was at its highest in 2005–09 (mean RCA value of 1.26) and has dropped in slow but steady fashion down to 0.94 in 2020–23. This is in contrast with Thailand which hovered around a mean RCA of unity and stepped-up to 1.20 in 2020–23. China, dropping from a high of 1.43 (1995–99) to 1.16 (2015–19), rebounded to 1.22 in 2020–23. The pace of closure between economies is developing, albeit non-uniform: China continues to be the clear ahead, and Thailand not far behind.

4.5 Statistical Tests

Table 10. Statistical Tests of RCA Differences Across Peer Economies

Test	Statistic	p-value	Sig.	Interpretation
One-Way ANOVA	F = 5.099	0.0001	***	Significant difference in mean RCA across economies
Kruskal–Wallis H	H = 349.19	< 0.0001	***	Non-parametric confirmation of inter-economy differences
India vs. China	U = 1,057,402	< 0.0001	***	India's distribution differs significantly from China
India vs. Brazil	U = 1,359,195	< 0.0001	***	India's distribution differs significantly from Brazil
India vs. Thailand	U = 1,195,866	< 0.0001	***	India's distribution differs significantly from Thailand
India vs. Viet Nam	U = 1,047,250	< 0.0001	***	India's distribution differs significantly from Viet Nam
India vs. Indonesia	U = 989,746	< 0.0001	***	India's distribution differs significantly from Indonesia

*Note: *** $p < 0.001$. Mann-Whitney U tests are two-tailed with India as the reference economy. Source: Authors' computations.*

All three tests reveal that there are differences in the peer group which are highly significant ($p < 0.001$), this confirms H1 and H2. The convergent evidence of the F = 5.10 and Kruskal-Wallis H = 349.19 is that the differences observed are not due solely to sampling error. The lowest U-statistic for India versus Brazil (1,359,195) identifies the most divergent distribution, whereas the highest for India versus Viet Nam (1,047,250) points to the most similar profiles among the five pairs.

V. Summary:

This paper compares the competitiveness of India's processed food export with five emerging economy peers — China, Brazil, Thailand, Viet Nam, and Indonesia — using UNCTAD trade data covering 9,685 economy-category-year observations over 1995 to 2023. China is at the head of the peer group with a mean RCA of 1.25 and 42.65% of observations located above unity, suggesting a strong nationwide industrial food processing capacity. India's rank jumps to 3rd highest (mean RCA= 1.06), however, it is the only peer to be the highest across two processing tiers: 1) Minimal Processing (RCA= 2.21) and 2) Ingredients (RCA= 2.57). This stature at the apex of both is not rivalled by any other peer economy. On the other hand, India has the least competitiveness (in Salt/ Sugar Processing) and Precursor (0.22) which are behind China by 0.64 and 1.04 respectively. Over time, India's competitiveness followed an inverse U-shape as it reached its peak in 2005–09 (mean RCA = 1.26) before slightly declining to 0.94 in 2020–23, contrasting with the longevity of Thailand and the unwavering superiority of China. The results demonstrate that although India has truly structural benefits for a number of early-stage processing areas, its participation in more complex value composite and precursor food categories is significantly behind that of rivals.

VI. Policy Implications

A specific best practice opportunity associated with cold chain investment and fisheries-related processing clusters is provided by Thailand's enduring Fermentation/Smoking competitiveness (mean RCA = 2.12 versus India's 0.76). India's overall declining RCA from 1.26 (2005–09) to 0.94 (2020–23) needs a strategic focus. Differentiating on quality branding, GI certification and access to premium markets in EU and Gulf Cooperation Council markets can support India in its area of strength in Minimal Processing and Ingredients – these are also areas involving concentrated global trade where India's leadership position must be vigorously protected and extended.

VII. Conclusion

This contribution is the first to analyse systematically India's processed food export competitiveness vis-a-vis five large emerging economy competitors using disaggregated RCA indices for a number of 87 categories over a time span of 29 years. India accounts for only 3% by overall mean RCA (1.06) but has a clear leadership position in Minimal Processing (2.21) and Ingredients (2.57) while it is barely competitive in Salt/Sugar Processing (0.39), Precursor (0.22), and Composite (0.78) segments. All inter-economy differences are statistically significant according to t-test ($p < 0.001$). India's comparative advantage was at its highest in the years 2005–09 and has been slowly decaying, while China has been stable and Thailand resilient. These trends suggest both defensive threats and offensive possibilities for India's processed foods trade policy.

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