Competition and Market Concentration in Tamarind Processing and Marketing: Insights from the Herfindahl-Hirschman Index and Concentration Ratio.

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ABSTRACT

This study examines the market structure, level of competition, and concentration among tamarind processors and marketers in Kano, Kaduna, and Nasarawa States of northern Nigeria. Using primary data from 2025 and employing the Herfindahl-Hirschman Index (HHI), the study assesses the distribution of market shares and the extent of dominance among participants in the tamarind value chain. Results show that the processing segment is highly competitive and atomistic across all states, with extremely low HHI values of 0.0000329 (Kano), 0.0000289 (Kaduna), and 0.0000196 (Nasarawa). The marketing segment demonstrates varying levels of competition, with Kano showing moderate concentration (HHI = 0.0022862), while Kaduna (0.0006102) and Nasarawa (0.0001246) exhibit low concentration and high competitiveness. The findings highlight a vibrant but fragmented industry characterized by low market power, limited economies of scale, and significant opportunities for new entrants. The joint application of CR_4 and HHI reveals a tight oligopolistic market structure in Kano State and highly concentrated, near-monopolistic structures in Kaduna and Nasarawa States, indicating significant market dominance by a few firms in tamarind processing.

INTRODUCTION

Tamarind (Tamarindus indica) contributes significantly to rural livelihoods in northern Nigeria. Understanding market structure and competition within its value chain is essential for evaluating market performance and designing appropriate policy interventions Tamarind (Tamarindus indica) plays an increasingly important role in Nigeria's non-timber forest product economy, particularly in northern states where processing and marketing offer income opportunities for rural households. However, understanding the extent of competition and market concentration in the tamarind value chain is crucial for assessing market performance, efficiency, and sustainability.

Market structure influences pricing behavior, revenue distribution, and the potential for firms to wield market power (Bain, 1959). The Herfindahl-Hirschman Index (HHI) has become a widely accepted tool for evaluating market concentration globally, with lower values signifying competitive markets and higher values indicating monopolistic tendencies.

Despite the economic relevance of tamarind, empirical studies on its market structure remain scarce. This study contributes to addressing this gap by evaluating competition among processors and marketers across Kano, Kaduna, and Nasarawa States using the Herfindahl-Hirschman Index (HHI).

METHODOLOGY

Study Area

The study was conducted in Kano, Kaduna, and Nasarawa States, which are major producers and marketers of tamarind in Nigeria. Each representing key nodes in northern Nigeria's tamarind value chain.

Data Collection

Primary data were collected from processors and marketers across the three states using structured questionnaires. data were obtained from 384 respondents comprising 171 processors in Kano, 133 in Kaduna, 80 in Nasarawa, and marketers across the three states. Data were collected on revenue levels, market share, and operational characteristics.

Sampling procedure and sample size

A multistage sampling procedure was employed to select the study sample.

Step 1:

Three states Kano and Kaduna and Nasarawa, were purposively selected due to their high levels of tamarind processing and marketing activities.

Step 2:

Within each state, Purposive sampling was use to select four (4) Local Government Areas (LGAs) with the most significant tamarind processing and marketing activities.

Step 3:

Subsequently, one (01) community each was selected using a simple random from a local government area to make it four communities each in a state. Yamanes formula was used to determine the number of respondents to be allocated to each states from the sample frame. Yamanes formular states:

$$\mathbf{n = N \div 1+N(e^2)}$$

n = sample size

N = Estimated Sample Size

e = margin error (5% or 0.05)

Kano Sample Size;

N = 300 processors and marketers (ADP Kano)

n = ?

$n = 300 \div 1 + 300(0.05)^2$

n = 171(Kano)

Kaduna Sample Size:

N = 200 Processors and marketers (ADP Kaduna)

$n = 200 \div 1+200(0.05)^2$

n = 133 (kaduna)

Nasarawa State Sample Size

N = 100 Processors and marketers (ADP Nasarawa State)

$n = 100 \div 1+100(0.05)^2$

n = 80

Step 4:

Proportionate sampling percentage was used to determine the number of respondents per community.

Proportionate sampling percentage was used for each LGA's

$n_i = (N_i \div N)n$

Percentage = $(N_i \div N) \times 100$.

Where N_i = population of the subgroup

N = Total population

Kano = $\left(\frac{171}{384}\right)$ x 100 = 42.75 (43%) for the 4 LGA.'s

Kaduna = $\left(\frac{133}{384}\right)$ x 100 = 35% for the 4 LGA's

Nasarawa = 80×100÷384 = 20% for the 4 LGA's

= 20%

Sampling Frame and Sample Size

States under study	Sample Frame	LGA's selected	Numbers of Communities selected	Numbers of respondents to select	Estimated population
Kano State	300 marketers and processors (ADP Kano State)	Madobi, Dawakin - Tofa , Kano-South and Kano-Central	04	44.5% respondents from each community using proportionate sampling (171)	300
Kaduna State	200 marketers and preocessors (ADP Kaduna State)	Chikun Zaria, Kaduna-South and Kaduna-North	04	34.6% respondents from each community using proportionate sampling (133)	200
Nasarawa State	100 Processors/Marketers (ADP Niger State)	Lafia, Nasarawa Eggon, Akwanga, Awe	04	20.8% 20respondents from the 4community each.(80)	100
3 States	**600**	**12 LGA's**	**12 Communities**	**384 Respondents**	**600 Population**

Analytical Technique

Market concentration was evaluated using the Herfindahl-Hirschman Index (HHI), and Concentration Ratio. HHI computed as the sum of squared market shares. Both indices are used to ensure the robustness . Using both allows you to capture dominance at the top (CR) and overall concentration (HHI).

The Herfindahl-Hirschman Index (HHI) was applied to determine market concentration. HHI was computed as:

$HHI = \sum_{i=1}^{N} s_i^2$

Where s_i represents the market share of each firm expressed in percentage, N= number of firms in the market. Interpretation follows U.S. Department of Justice standards:

- **HHI < 0.01**: Highly competitive/unconcentrated
- **0.01 ≤ HHI ≤ 0.15**: Moderately concentrated
- **HHI > 0.15**: Highly concentrated/monopolistic

Descriptive statistics complemented the HHI analysis.

CR_4 < 40% → Competitive market

CR_4 = 40–59% → Loose oligopoly

CR_4 = 60–79% → Tight oligopoly

CR_4 ≥ 80% → Highly concentrated / near monopoly

3. Results and Discussion

Market Structure of Tamarind Processors

Table 1: Market Structure of Tamarind Processors in Kano, Kaduna, and Nasarawa States

Variable	Kano (n=133)	Kaduna (n=77)	Nasarawa (n=8)
Mean revenue (₦)	2,436,789	2,181,117	1,794,438
Mean revenue share	0.0035936	0.0032165	0.0026463
Herfindahl-Hirschman Index (HHI)	0.0000329	0.0000289	0.0000196

Source: Field Survey, 2025

Market Structure of Tamarind Marketers

Table 2: Market Structure of Tamarind Marketers in Kano, Kaduna, and Nasarawa States

Variable	Kano	Kaduna	Nasarawa
Mean revenue (₦)	1,160,592	1,937,415	439,980.80
Mean revenue share	0.0024852	0.001405	0.0006946

Herfindahl-Hirschman Index (HHI)	0.0022862	0.0006102	0.0001246

Source: Field Survey, 2025

Market Structure of Tamarind Processors

The market structure for processors across the three states is summarized in the Table 1 above.

Revenue Levels and Market Participation

Mean revenue varied significantly across states, with Kano leading (₦2,436,789), followed by Kaduna (₦2,181,117) and Nasarawa (₦1,794,438). Kano's higher revenue aligns with its large market size, better-developed processing infrastructure, and integration into regional and cross-border trade networks (Abdulsalam & Ibrahim, 2021). Nasarawa's much lower revenue suggests limited processing activity or reduced access to markets.

Market Fragmentation and Revenue Share

The mean revenue share across processors was very low in all states, indicating that no single processor commands a dominant share of the market. This high level of fragmentation is typical of agro-processing sectors dominated by micro- and small-scale

enterprises (Adebayo et al., 2020). The small market shares also reflect intense inter-firm competition and limited ability to influence market prices.

Market Concentration (HHI Analysis)

HHI values for processors were extremely low:

- **Kano: 0.0000329**
- **Kaduna: 0.0000289**
- **Nasarawa: 0.0000196**

These values are far below the 0.01 threshold, indicating a highly competitive market. The findings align with Ume et al. (2020), who reported similar levels of fragmentation in informal agricultural processing clusters in Nigeria.

Implications:

- Wide participation and open entry characterize the processing sector.
- However, the absence of dominant players may reflect limited access to capital, technology, and scaling opportunities.
- Policymakers may need to address structural constraints inhibiting enterprise growth.

Market Structure of Tamarind Marketers

Kano: Moderately Concentrated Market

Results in Table 2 shows that Kano recorded the highest HHI (0.0022862), suggesting a moderately concentrated marketing structure. While numerous marketers operate in the state, a few large marketers still exert noticeable

influence over market dynamics. Barriers such as capital requirements and established distribution networks may contribute to this moderate concentration.

Kaduna: Competitive and Fragmented Market

With an HHI of 0.0006102 and a low revenue share (0.001405), Kaduna's tamarind marketing landscape is highly competitive and characterized by many small-scale marketers. The openness of the market creates room for new entrants but may limit the ability of businesses to scale.

Nasarawa: Most Fragmented Market

Nasarawa had the lowest HHI (0.0001246), indicating the most competitive and fragmented market among the three states. The very small revenue share shows that no marketer has significant influence. While beneficial for market access and price competition, this extreme fragmentation may constrain profitability and discourage investment in value-adding activities.

Market Concentration (CR_4 Analysis)

Concentration Ratio (CR_4) Analysis for Kano State

firms arrange by market share (largest to smallest)

Firm 5 = 25.9%

Firm 1 = 23.3%

Firm 2 = 15.2%

Firm 7 = 9.7%

Step 2: Compute the Concentration Ratio (CR_4)

CR_4 = Market share of the four largest firms

CR_4 = 25.9% + 23.3% + 15.2% + 9.7%.

CR_4 = 74.1%

Interpretation

The four largest tamarind processing firms in Kano State control 74.1% of the total market share, indicating a high level of market concentration.

Based on standard concentration ratio benchmarks:

$CR_4 < 40\%$ → Competitive market

CR_4 = 40–59% → Loose oligopoly

CR_4 = 60–79% → Tight oligopoly

$CR_4 \geq 80\%$ → Highly concentrated / near monopoly

A CR_4 value of 74.1% places the Kano tamarind processing market within a tight oligopolistic market structure.

Economic Meaning

A few dominant firms exert significant control over the market.

Smaller firms exist but have limited influence on pricing and output decisions.

There is potential for market power, price coordination, and barriers to entry.

Competition exists, but it is not perfectly competitive.

The concentration ratio analysis reveals that the four largest tamarind processing firms in Kano State account for 74.1% of total market share, indicating a tight oligopolistic market structure. This suggests that market activities are dominated by a few large firms, with implications for competition, pricing behavior, and market access for smaller processors.

Concentration Ratio (CR_4) Results for Kaduna and Nasarawa States

The concentration ratio analysis reveals extremely high levels of market concentration in both Kaduna and Nasarawa States.

In Kaduna State, the CR_4 value of 99.3% indicates that the four largest tamarind processing firms jointly control almost the entire market. This level of concentration signifies a highly concentrated market structure, bordering on near monopoly. The dominance of a few firms suggests substantial market power, limited competitive pressure, and significant barriers to entry for smaller processors.

Similarly, Nasarawa State records an even higher CR_4 value of 99.9%, implying that virtually all market activities are controlled by the top four firms. This reflects an extreme form of market concentration, consistent with a near-monopolistic or dominant oligopolistic structure. In such a market, competition is minimal, and pricing as well as output decisions are likely influenced by the dominant firms.

Comparative Insight and Policy Implications

When compared with Kano State, which

exhibits a tight oligopolistic structure, both Kaduna and Nasarawa States display far weaker competitive conditions. The overwhelming concentration observed in these states suggests:

Limited participation of small-scale processors

Potential for price manipulation and collusive behavior

Reduced market efficiency and innovation

The need for policies that encourage entry, support small processors, and improve access to finance and technology

The CR_4 results indicate a tight oligopoly in Kano State (74.1%), while Kaduna (99.3%) and Nasarawa (99.9%) exhibit highly concentrated, near-monopolistic market structures, suggesting that tamarind processing in these states is dominated by a few large firms with significant market power.

Integrated Interpretation of Market Concentration Using CR_4 and HHI

The market structure of tamarind processing across Kano, Kaduna, and Nasarawa States was jointly assessed using the Concentration Ratio (CR_4) and the Herfindahl–Hirschman Index (HHI) in order to provide a robust evaluation of market concentration and competitiveness.

In Kano State, the CR_4 value of 74.1% indicates a tight oligopolistic market structure, where the four largest firms dominate a substantial share of the market. This finding is consistent with the HHI results, which also reflect a high level of concentration, confirming that market activities are controlled by a few relatively large processors, although smaller firms still maintain some presence.

In contrast, Kaduna State exhibits an exceptionally high CR_4 of 99.3%, implying that nearly the entire market is controlled by the top four firms. Similarly, Nasarawa State, with a CR_4 value of 99.9%, demonstrates an extreme level of market concentration, where virtually all market share is held by the four largest firms.

Overall Implication

The combined evidence from CR_4 and HHI

clearly indicates that while Kano State operates under a tight oligopoly, the tamarind processing markets in Kaduna and Nasarawa States are highly concentrated and weakly competitive

Kano State

The market structure of tamarind processing in Kano State is characterized by an HHI value of 0.0022862 and a CR_4 of 74.1%, indicating a high but comparatively lower level of concentration relative to Kaduna and Nasarawa States. The concentration ratio result shows that the four largest processors control nearly three-quarters of the total market, which is indicative of a tight oligopolistic market structure.

The HHI value for Kano State, which is substantially higher than those recorded for Kaduna and Nasarawa, suggests a greater dispersion of market shares among firms and a more active competitive environment. This reflects the presence of a larger number of firms with relatively meaningful market shares, reducing the degree of dominance exercised by the leading processors. While the top firms remain influential, smaller processors in Kano appear to have a more significant role in market participation compared to their counterparts in the other states. The combined interpretation of CR_4 and HHI therefore indicates that tamarind processing in Kano State operates under a tight oligopoly with moderate competitive pressure. Unlike Kaduna and Nasarawa, where market control is almost absolute among the top firms, Kano exhibits relatively stronger competition, though still far from perfect competition.

Comparative Insight

In comparison with Kaduna and Nasarawa States, Kano State displays a less concentrated and more competitive market structure. The lower CR_4 and higher HHI values suggest that while a few firms dominate, market power is less extreme and more widely distributed, allowing for some degree of rivalry and entry opportunities.

The CR_4 and HHI results for Kano State reveal a tight oligopolistic market structure with relatively stronger competitive conditions compared to Kaduna and Nasarawa States, where market concentration is substantially higher.

Kaduna state

The market structure of tamarind processing in Kaduna State is characterized by an HHI value of 0.0006102 alongside a CR_4 of 99.3%, indicating a market with extreme dominance by a few firms. The concentration ratio result shows that the four largest processors collectively control almost the entire market, reflecting a highly concentrated market structure approaching near monopoly. This suggests substantial market power, limited competitive rivalry, and strong barriers to entry for smaller or potential processors.

The HHI value, though numerically low, provides additional insight when interpreted alongside the CR_4. The relatively higher HHI for Kaduna compared with Nasarawa indicates greater inequality in market share distribution among firms, implying that dominant firms in Kaduna hold comparatively larger individual market shares. This suggests a market structure where dominant processors exert stronger control, while smaller firms operate at the margins with limited influence on market outcomes.

The joint interpretation of both indices therefore indicates that tamarind processing in Kaduna State is dominated by a small group of firms, with competition largely confined to a weak competitive fringe. While numerous smaller processors may exist, their cumulative market share is negligible, limiting their ability to challenge dominant firms or influence pricing and output decisions.

Comparative Insight

Compared with Nasarawa State, Kaduna exhibits a slightly less extreme but still highly concentrated structure, as reflected by its marginally lower CR_4 and higher HHI. This suggests that although both markets are near-monopolistic, market power in Kaduna is more unevenly distributed among the leading firms, reinforcing their dominance.

The combined CR_4 and HHI results indicate that tamarind processing in Kaduna State operates under a highly concentrated, near-monopolistic market structure, with a few dominant firms exerting significant control over market activities while smaller processors remain largely marginalized.

Nasarawa State

The results for Nasarawa State reveal an apparently contrasting outcome between the two concentration measures, with an HHI value of 0.0001246 and a CR_4 of 99.9%. The concentration ratio (CR_4) indicates an extremely high level of market concentration, suggesting that the four largest tamarind processing firms jointly control virtually the entire market. This outcome implies a near-monopolistic or dominant oligopolistic market structure, characterized by substantial market power, limited competition, and high barriers to entry for smaller processors.

In contrast, the very low HHI value suggests a low degree of overall concentration when market shares of all firms are considered. This apparent inconsistency can be attributed to the large number of firms operating at very small and relatively similar market shares beyond the dominant firms, which reduces the HHI despite the overwhelming dominance of the top four firms. Unlike CR_4, which focuses solely on the largest firms, HHI is sensitive to the distribution of market shares across the entire industry.

Taken together, the joint interpretation of both indices indicates that while market control in Nasarawa State is heavily concentrated among a few dominant firms (as reflected by CR_4), the presence of numerous marginal processors with very small market shares dilutes the HHI value. This structure reflects a market where competitive fringe firms coexist with dominant processors, but exert little influence on pricing and output decisions

4. Conclusion and Recommendations

The study shows that tamarind processing is highly competitive across the study area, while marketing shows varying degrees of concentration,

- Tamarind processing is highly competitive and atomistic across Kano, Kaduna, and Nasarawa.
- Tamarind marketing varies in concentration, with Kano moderately concentrated, while Kaduna and Nasarawa are highly competitive.
- Fragmentation across the value chain limits economies of scale and hampers profitability.
- Despite the high level of competition, market efficiency is constrained by limited capital, inadequate processing/marketing infrastructure, and weak market integration.

RECOMMENDATIONS

Policy efforts should focus on strengthening value addition, cooperative formation, financing access, and improved market linkages.

Promote Cooperative Formation:

Encouraging processors and marketers to form cooperatives can enhance bargaining power, market access, and access to credit.

Strengthen Value Addition:

Government and NGOs should support investment in modern processing technologies to improve scale and quality.

Enhance Market Linkages:

Connecting small processors to larger buyers, exporters, and industrial users can expand market opportunities.

Improve Access to Finance:

Tailored credit schemes for micro- and small-scale agro-processors should be developed.

Capacity-Building Programs:

Training in quality control, packaging, and market intelligence can enhance competitiveness.

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