

Improving Community Economic Independence Through Downstreaming Andaliman into Ready-To-Drink Juice Products

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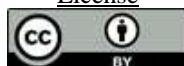
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ABSTRACT

This Community Service (PKM) was carried out by lecturers and students of the Business Administration Study Program, Faculty of Social and Political Sciences, HKBP Nommensen University, Medan, Postgraduate Students of the Faculty of Economics, University of North Sumatra, in collaboration with the Regional Management Board (DPD) of MARTABE North Sumatra, located at Jl. Until No. 260 Medan, MARTABE North Sumatra was a community that contributed ideas to develop North Sumatra Province in terms of creativity and community innovation as Martabe members to improve the household economy. This Community Service (PKM) was carried out with the aim of empowering the MARTABE North Sumatra community as members. Through this PKM, the community as MARTABE members is empowered through training on how to process Andaliman raw materials with various other mixed ingredients so that they can be accepted by the market as quality drinks. This program is expected to be a sustainable solution for increasing the added value of andaliman by processing it into functional beverage products. With strong processing and marketing skills, the community can achieve increased income and economic independence. Downstreaming andaliman into ready-to-drink juice is not simply a technical process but a multidimensional intervention that combines food science, microeconomics, community empowerment, and marketing strategies. The program's success depends on an integrated approach: scientific product validation, human capacity building, realistic business model, and regulatory compliance. With this foundation, this Community Service (PKM) program has the potential to generate tangible and sustainable economic impacts for MARTABE community members in North Sumatra.

Keywords: Community Service (PKM), Community Empowerment, Economic Independence

INTRODUCTION:

Andaliman (*Zanthoxylum acanthopodium*) is a spice plant native to the mountains of North Sumatra, particularly the Tapanuli and Samosir regions, with a distinctive spicy flavor and unique aroma. Until now, its use has been limited to traditional cooking spices, thus its economic value has not been maximized for the farming communities that cultivate it (Sulaiman, Adi, & Runtiko, 2022).

However, the selling price of andaliman fluctuates seasonally. During peak harvest times, prices drop drastically due to the lack of processing that can increase its added value (Abdullah, Syahri, Hamamah, Gafur, & Sholeh, 2024). This makes farmers' income unstable. Scientifically, andaliman has the potential to be an ingredient in an antioxidant herbal drink that is beneficial for health and, therefore, can be developed into an economically viable ready-to-drink juice product (Saragih, 2019).

Downstream processing of andaliman juice presents a strategic opportunity to enhance the competitiveness of local products, expand markets, and increase community income. Through training in production, packaging, and marketing, farming communities gain additional skills in processing their harvest into high-value products (Tuanaya, 2024).

Andaliman (*Zanthoxylum acanthopodium*) is endemic to North Sumatra, particularly in Tapanuli, Samosir, and Humbang Hasundutan regions. Andaliman has a distinctive, pungent flavor and contains active

compounds such as alkaloids, flavonoids, terpenoids, and essential oils with antioxidant, antimicrobial, and anti-inflammatory properties (Shelly Christiani Saputri, Hergianasari, & Therik, 2022). Owing to these bioactive compounds, andaliman has great potential as a raw material for functional herbal drinks that support health (Siagian, 2024b).

However, in the context of the local agricultural economy, andaliman is still predominantly used as a traditional cooking spice without adequate downstream processing. The selling price of andaliman remains highly dependent on harvest season (Siagian, 2024e). When harvest is abundant, prices at the farm level drop significantly because of the lack of product diversification and long-term storage mechanisms. This situation results in fluctuating farmer incomes and vulnerability to market price volatility (Ismail, Sumardjo, Kinseng, & Sari, 2022).

However, current consumer trends indicate a growing interest in healthy, natural-based beverages (herbal-based functional beverages). Modern consumers tend to choose products that not only offer health benefits, but are also practical and have a local identity (Mubarok, Fadli Muhamad, & Kusuma, 2024). This opens up significant opportunities for downstreaming andaliman into ready-to-drink juice, a form of functional beverage innovation with high economic value (Siagian, 2024c).

Downstreaming itself is an economic development strategy aimed at increasing the added value of agricultural commodities through processing, so that commodities are not only sold as raw materials (Rustidja, Purnamawati, & Setiawati, 2017). In the context of the Andaliman farming community, downstreaming can be an instrument of economic empowerment, as it empowers farmers not only to produce, but also to process, package, and market products independently (Sarma, Septiani, & Nanere, 2022).

Based on this description, an empowerment program is needed in the form of training in processing andaliman into ready-to-drink functional beverage products to increase the economic independence of the community (Nurfarkhana, 2023). Through the empowerment program in the form of training in Andoman juice production, hygienic packaging, and digital-based marketing strategies (Siagian, 2024d), the community is expected to obtain: (1) transfer of new knowledge and skills, (2) opportunities for the formation of local business units, and (3) increased income through the sale of high-value-added products (Syarifuddin, 2022).

Thus, this activity not only impacts the economy but also strengthens the identity of local culinary culture, opens broader market access, and promotes sustainable economic independence for the community (W, Kunyanti, & Mujiono, 2021). Therefore, systematic efforts through the Community Service Program (PKM-PM) are needed to realize the downstreaming of andaliman into innovative, high-quality, and market-competitive ready-to-drink juice products (Wahab, Arsyad, & Syahrani, 2021).



Figure 1. Implementation of Socialization

The aim of this PKM activity is to (1) provide technical training in processing andaliman into ready-to-drink juice, (2) improve community skills in product packaging and branding strategies, and (3) encourage the formation of andaliman-based small business units to increase income (Siagian, 2024a).

Andaliman as a Local Commodity

Andaliman is known to contain alkaloids, flavonoids, and essential oils, which act as antioxidants. This content makes it a potential ingredient in health drinks (Bakalo, Makhovka, Krekoten, Glebova, & Kulakova, 2025).

Andaliman (*Zanthoxylum acanthopodium*) is a spice plant endemic to the highlands of North Sumatra, particularly in Tapanuli, Humbang Hasundutan, Samosir, and surrounding areas (Siagian, 2023a). Botanically, andaliman belongs to the Rutaceae family and is known for its distinctive aroma and numbing sensation due to the compound sanshool (Asfaw et al., 2024).



Figure 2. Speech by the Chairman of the DPP Martabe St. Robet Siregar

The bioactive compounds of andaliman, such as flavonoids, alkaloids, essential oils, tannins, and phenolics, have antioxidant, antimicrobial, and anti-inflammatory properties (Syahputra, 2021). Until now, its use has been limited to traditional dishes such as saksang, arsik, and sambal tuktuk, resulting in suboptimal economic value due to the lack of adequate downstream processing (Siagian, 2023b).

Community empowerment

Empowerment is the process of increasing a community's capacity to become economically, socially, and skillfully independent (Mitra & Putra, 2024). Empowerment is carried out through production and marketing training (Sutrisno, 2020).

Community empowerment is the process of increasing the capacity and economic independence of a group through training, mentoring, institutional strengthening, and market access (Mulyandi & Yumeina, 2024).

The principles of empowerment include (a). Participation (community involvement in every activity stage) (b). Independent (sustainable program results without dependency) (c). Capacity building (increased knowledge & skills) (Utami, Hasriyanti, & Vanziru, 2023).



Figure 3. Socialization and Training

METHODOLOGY

Location and Target

This Community Service (PKM) was carried out at the Office of the Regional Management Board (DPD) MARTABE North Sumatra, which is located in Jl. Sampali No. 260 Medan, MARTABE North Sumatra is a community that contributes ideas to develop the Province of North Sumatra in terms of creativity, community innovation as members of Martabe to improve the household economy (Harun, Pushiri, Amirul-Aiman, & Zulkeflee, 2021). This Community Service (PKM) program aims to empower members of the MARTABE community in North Sumatra (Syahputra, 2021). Through this program, MARTABE members are trained in how to process Andaliman with various other ingredients to create a quality beverage (Saud, Asterina, & Trisha, 2020).

Implementation Stages

The implementation of Community Service (PKM) activities is conducted in several stages.

1. Preparation: Survey of needs and coordination with Martabe Management at the Village Level North Sumatra to collect data and readiness of the management and members.
2. Production training: Training in cleaning, extraction, and juice formulation, with the aim of making people skilled in processing juice.
3. Packaging and Branding: Designing labels, bottles, and product brands so that the product has an identity in the market.
4. Marketing: Digital & offline marketing training to make the product ready for sale.
5. Evaluation: Monitor sales and quality to further increase measurable community income (Üzümcüoğlu & Polay, 2022).

Materials and Equipment

1. Fresh Andaliman
2. Lime / Lemon
3. Boiled water
4. Blender & strainer machine
5. Food-grade packaging bottles
6. Product labels and stickers



Figure 4. Processing Process

Andaliman Juice Making Procedure

1. Sort fresh andaliman, wash clean.
2. Soak in hot water to reduce the bitter taste.
3. Blend with the following composition: andaliman: water: orange flavor (1:4:1).
4. Strain and lightly pasteurize.
5. Cool and pack in sterile bottles.



Figure 5. Raw Material Processing Process

RESEARCH RESULTS AND DISCUSSION

Andaliman's Potential as a Functional Raw Material

Andaliman (*Zanthoxylum acanthopodium*) contains bioactive compounds, such as flavonoids, alkaloids, essential oils, and phenolic compounds, that exhibit antioxidant, antimicrobial, and anti-inflammatory activities (Tuanaya, 2024). Theoretically, these properties make andaliman a potential raw material for functional beverages targeting health-conscious consumers. Utilizing these functional properties in juice formulations can increase product value and create a unique selling proposition (USP) based on its properties and local identity (Sulaiman et al., 2022).

Processing Technology and Quality Parameters

To maintain nutritional quality and microbiological safety, recommended processing technologies include:

1. Extraction: Use a blender and sieve or a cold extractor to retain volatile compounds. The ingredient-to-water ratio should be tested (initial example 1:3–1:5 weight/volume) and adjusted based on sensory and stability testing (Abdullah et al., 2024).
2. Pasteurization: two practical options—LTLT (63°C for 30 min) for small-scale production and HTST (72°C for 15 s) for greater efficiency and quality. These parameters must be validated for microbial safety without destroying the critical functional compounds.
3. Natural preservatives such as citric acid, honey, or stevia as natural sweeteners and pH stabilizers use safe concentrations as stated on the label. For non-refrigerated shelf-stable products, aseptic technology and sterile packaging or the addition of registered preservatives and shelf-life testing are required (Shelly Christiani Saputri et al., 2022).
4. Quality control: pH measurement, Brix (°Bx) for dissolved sugar/solid content, water activity (aw), color, and microbiological examination (TPC, coliform, yeast, and mold). Initial target: pH < 4.5 (safer against the growth of pathogenic bacteria), Brix according to consumer preference (12–16 °Bx for sweet-moderate juice), and low aw if intended for a long shelf life (Mubarok et al., 2024).

Formulation, Sensory, and Product Optimization

A good formulation combines flavor (the distinctive spicy numbing of Andaliman), freshness (orange/lemon), and balance (a natural sweetener) (Ismail et al., 2022). Scientific strategy:

1. Formulation experiments used Design of Experiments (e.g., Response Surface Methodology) to determine the optimal composition (percentage of andaliman, sugar/sweetener content, acid, and water).
2. Sensory testing: trained panel and consumer panel (acceptability test) for aroma, taste, aftertaste (numbing sensation), color, and overall preference attributes. Statistical analysis (ANOVA, Tukey) was used to compare the formulations (Fauzani, Putri Ratna Kencana, Sirajudin Al Aksari, & Lakoni Pribadi Putra, 2024).
3. Stability study: observation of organoleptic, pH, Brix, and microbiological changes during the storage period in cold conditions (4°C) and room temperature according to marketing targets.



Figure 6. PKM participants

Shelf-life and Food Safety Guarantee

The final shelf life depends on pasteurization, sanitation, and packaging processes. Initial estimate (subject to laboratory testing):

1. Chilled product (refrigerated, light pasteurization): 7–14 days with maintained organoleptic quality.

2. Long-shelf-life products (aseptic, sterile packaging + appropriate preservatives): 3–6 months — require microbiological and chemical validation (challenge test).
3. Recommended tests: total plate count and coliform/*E. coli*, *Salmonella* spp., yeast, and mold; and chemical tests: pH, Brix, and residual alcohol content (if fermentation is not desired). Compliance with the BPOM standards and halal certification can increase market confidence.

Economic Aspects and Feasibility Analysis

Downstream processing increases profit margins for local producers, because the selling price of processed products is typically several times that of raw materials. The main cost components are raw materials, labor, processing equipment, packaging, registration/certification costs, and marketing. A simple analysis:

1. Pricing: The selling price must cover variable costs + operating margin and compare the prices of similar products (local/premium herbal drinks) (Destiani Andilas, Jiwa Husada Tarigan, Br Sitepu, & Raza, 2020).
2. Benefits for farmers: diversification of income from sales of raw materials and/or empowerment of production by community groups that process them themselves.
3. Scalability: Cooperative or joint MSME models can lower unit costs and increase bargaining power.
4. It is recommended that a simple economic feasibility study (break-even point, Payback Period) be conducted in the follow-up business plan.

Marketing Strategy and Market Development

To penetrate the market, this PKM provides breakthroughs that must be carried out by the community as PKM participants, including

1. Market segmentation: health-conscious consumers, local culinary tourism markets, souvenir markets, and millennial segmentation for regional specialty products.
2. Branding: highlight local wisdom aspects (e.g. “Andaliman Juice, a Tapanuli Heritage”), validated functional claims, and aesthetic packaging.
3. Distribution channels: direct-to-consumer (online), local shops/stalls, traditional markets, collaboration with tourist hotels/restaurants.
4. Promotion: sampling, collaboration with local culinary influencers, and participation in culinary events/MSME exhibitions.
5. Product registration with the BPOM (NA or MD) and halal certification will facilitate access to modern markets (supermarkets and e-commerce platforms).

Social Empowerment and Production Organization Models

PKM programs must link technical aspects with social empowerment:

1. Formation of processing groups/cooperatives to manage production, purchase raw materials, and joint marketing.
2. Tiered training: Processing techniques, quality management, simple financial recording, and digital marketing.
3. A fair profit-sharing scheme (i.e. production transparency and sales reports) supports business sustainability.
4. This model increases income and strengthens the social capital and institutional capacity of the community.

Risks, Barriers, and Mitigation Strategies

Identify key risks:

1. Seasonality and availability of raw materials → Mitigation: scheduled planting and purchasing contracts with farmers.
2. Microbial contamination → mitigation: hygiene training, sanitation, pasteurization validation.
3. Market acceptance (numbing sensation may be unfamiliar to some consumers) → mitigation: formulation that balances the numbing sensation with citrus, sweetness, and product education through sampling.
4. Regulation and certification → allocate budget and time for the BPOM/halal registration process.

Success Indicators and Monitoring-Evaluation

Suggested quantitative and qualitative indicators to assess impact:

1. Quantitative: number of farmers/group members involved; number of products sold per month; average increase in farmer income (%) over 6–12 months; number of new business units formed.
2. Qualitative: Level of training participant satisfaction; improvement in managerial skills (pre-post training assessment).
3. Data collection methods included household surveys, group sales reports, periodic laboratory tests, and

Recommendations for Further Development

1. Antioxidant activity tests (e.g., DPPH) and antimicrobial tests were performed to support functional claims.
2. Design stability tests and microbiological challenge tests to determine valid shelf-life.
3. Develop derivative products (andaliman syrup, instant powder, and essential oil extract capsules) to diversify the market.
4. Form partnerships with research institutions/polytechnics for technology transfer and laboratory access.

CONCLUSIONS

This program is expected to be a sustainable solution to increase the added value of andaliman by processing it into functional beverages. With strong processing and marketing skills, farming communities can achieve increased income and economic independence.

Downstreaming andaliman into ready-to-drink juice is not simply a technical process but a multidimensional intervention that combines food science, microeconomics, community empowerment, and marketing strategies. The program's success depends on an integrated approach: scientific product validation, human capacity building, realistic business model, and regulatory compliance. With this foundation, the Community Service Program (PKM) has the potential to generate real and sustainable economic impacts for Angaliman farming communities.

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