

Evaluating the Impact of a Community-Based Quality Management Intervention on Hygiene Practices and Shelf-Life of Cassava Tape in Sumedang Regency

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ABSTRACT

Cassava tape is a traditional fermented food widely produced by household-scale enterprises in Sumedang Regency; however, hygiene inconsistencies and limited fermentation control often reduce product shelf life and quality. This study aimed to evaluate the effectiveness of a community-based quality management intervention in improving hygiene practices and product durability among small-scale cassava tape producers. A mixed-method approach based on the explanatory design of Jack R. Fraenkel and Wallen was employed, integrating quantitative and qualitative data. Five producers participated using total sampling. The intervention was conducted over three weeks and included baseline assessment, structured training, practical demonstration, and three weekly monitoring sessions. Data were collected using a 10-item Likert scale questionnaire and semi-structured interviews. Quantitative data were analyzed using Microsoft Excel through descriptive statistics and a paired sample t-test at a 0.05 significance level. Results showed that the mean hygiene score increased from 3.02 to 4.28, representing a 41.7 percent improvement. The paired t-test indicated that the increase was statistically significant ($p < 0.05$). Shelf life observation further revealed an extension from three to four days to five to six days under room temperature storage. Qualitative findings supported improved awareness of contamination risks and better fermentation control. These findings suggest that structured community-based quality management interventions can produce measurable and statistically supported improvements in hygiene compliance and product durability in traditional cassava fermentation systems

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INTRODUCTION

Cassava tape (tape singkong) is a traditional Indonesian fermented cassava product characterized by a sweet taste, soft texture, slight acidity, and mild alcoholic aroma. Fermentation is initiated using ragi (starter culture) containing yeasts, molds, and lactic acid bacteria. Microbiological studies consistently report the dominance of *Saccharomyces cerevisiae*, *Lactobacillus plantarum*, and *Bacillus subtilis*, with microbial counts reaching 10^7 – 10^8 CFU/g during active fermentation (Barus et al., 2011; Hasanah et al., 2019). Earlier foundational work demonstrated that cassava fermentation is exothermic, anaerobic, and occurs optimally at approximately 35°C in two stages involving lactic acid and alcohol production (Akinrele et al., 1964; Ngaba et al., 1979). Lactic acid bacteria remain the dominant microflora throughout fermentation (Kimaryo et al., 2000).

Detoxification of cassava is a critical safety function of fermentation. Cyanogenic compounds can be reduced by more than 70% through bacterial linamarase activity (Kobawila et al., 2005), with documented reductions from 258.9 to 17 mg HCN/kg (Tivana et al., 2007). Nutritional enhancement, including improved protein and vitamin availability, has also been widely reported (Aro et al., 2008).

Economically, cassava tape production represents a viable microenterprise, with R/C ratios between 1.59 and 1.6 reported in regional analyses (Nurhayati et al., 2019). Production innovations such as integrated fermentation systems have extended shelf life up to seven days (Kurniawan et al., 2025). Other preservation approaches for cassava roots and derivatives—including xanthan–guar gum coatings (Oduor et al., 2017), chitosan–antioxidant treatments (Akitoye et al., 2024), simple storage bags (Tomlins et al., 2021), moist sand storage (Quevedo et al., 2014), fermented cassava flour (Lestari et al., 2019), and sodium benzoate treatments (Valentine et al., 2023)—demonstrate that technological intervention can significantly extend shelf life. However, many of these approaches may not apply to small-scale traditional tape producers due to cost, accessibility, or cultural constraints.

Food safety remains a major global public health concern. Approximately 600 million people experience foodborne illnesses annually, resulting in 420,000 deaths worldwide (Fukuda et al., 2015; Othman et al., 2022; Ulfat et al., 2025). Food contaminants—including bacteria, viruses, parasites, and chemical hazards—are responsible for more than 200 diseases (Fukuda et al., 2015). Risk can occur across the entire supply chain, from production to consumption (Shiigi et al., 2019), requiring coordinated multi-stakeholder engagement (Jaffee et al., 2018). In traditional food systems, safety challenges include unhygienic processing environments, cross-contamination, and inconsistent quality control (Aworh et al., 2008; Aworh et al., 2022; Asogwa et al., 2017). Additionally, high-temperature traditional processing may pose chemical risks such as acrylamide formation (Adimas et al., 2024).

Traditional food processing methods—including fermentation, drying, and smoking—play a crucial role in food security and rural development (Hossain et al., 2019; Tegan David et al., 2024). Despite their benefits, safety assurance mechanisms are often informal and experience-based. Quality Food Management Systems (QMS) provide structured frameworks integrating quality design, control, assurance, and continuous improvement (Luning et al., 2002; Luning et al., 2009). Implementation of Good Manufacturing Practices (GMP) and Hazard Analysis Critical Control Points (HACCP) enhances safety and consistency (Barbosa et al., 2016). A comprehensive review of 102 studies confirms the centrality of quality management in food systems (Literature Review on Quality, 1993–2022). Emerging approaches integrate Industry 4.0 technologies such as sensors and blockchain (Peres et al., 2025), although such applications remain limited in small-scale traditional production contexts.

Despite extensive literature on fermentation microbiology, preservation technologies, traditional food systems, and quality management frameworks, limited empirical studies evaluate community-based quality management interventions targeting hygiene improvement and measurable shelf-life enhancement among household-scale cassava tape producers.

In Sumedang Regency, cassava tape production is predominantly carried out by household-scale producers using traditional methods. Observations indicate variability in sanitation practices, fermentation control, and storage management, which may contribute to reduced shelf life and inconsistent product quality. While technological preservation methods such as edible coatings and chemical preservatives have demonstrated effectiveness in cassava products (Oduor et al., 2017; Akitoye et al., 2024), such approaches may not be feasible or culturally appropriate for small-scale traditional producers.

Therefore, this study aims to:

- improve hygiene practices in cassava tape production through community-based quality management training;
- enhance fermentation control techniques among household producers; and
- evaluate changes in hygiene compliance and product shelf life following the intervention.

By integrating principles of food hygiene and quality management into a community-based intervention model, this study seeks to provide an applied framework for improving the safety, durability, and economic sustainability of traditional cassava tape production.

METHOD

This study employed a mixed-method approach based on the explanatory design framework proposed by Jack R. Fraenkel and Wallen (2012), integrating quantitative and qualitative data to obtain a comprehensive evaluation of a community-based quality management intervention. The quantitative component was used to measure changes in hygiene knowledge and production practices through structured questionnaires, while the qualitative component explored behavioral changes, production challenges, and fermentation management through in-depth interviews and field observations. The integration of both approaches allowed triangulation to strengthen the validity of findings.

The study was conducted at a cassava tape production center in Sumedang Regency, involving five household-scale producers operating within the same production environment. Due to the small population size, total sampling was applied, and all five producers participated in the study. Each participant was directly involved in cassava preparation, fermentation using *ragi* starter culture, packaging, and storage processes.

The intervention lasted three weeks and was structured as a community-based quality management program. Week one began with baseline data collection, including pre-intervention questionnaire distribution, semi-structured interviews, and direct observation of production practices. Weeks two and three involved implementation of hygiene and fermentation control improvements, accompanied by periodic monitoring conducted three times at one-week intervals. Each monitoring session evaluated compliance with hygiene procedures, fermentation consistency, and storage practices.

The quantitative instrument consisted of a 10-item questionnaire developed based on food hygiene principles and quality management frameworks, including Good Manufacturing Practices and Hazard Analysis and Critical Control Point concepts outlined by the Food and Agriculture Organization and

World Health Organization, as well as quality management models described by Pieterneel Luning et al. The indicators were aligned with Indonesian food safety standards issued by Badan Standardisasi Nasional. The questionnaire measured personal hygiene, equipment sanitation, fermentation control, packaging practices, and storage management. Responses were scored using a five-point Likert scale ranging from 1, strongly disagree, to 5, strongly agree. The instrument was administered before the intervention and again at the end of week three to evaluate changes.

Quantitative data were analyzed using descriptive statistical techniques with Microsoft Excel. Mean scores were calculated for pre-intervention and post-intervention results, and percentage improvements were computed to determine the magnitude of change. The findings indicated a substantial increase in hygiene knowledge and compliance scores after the intervention period, reflecting significant behavioral improvement among producers.

Qualitative data were obtained through semi-structured interviews conducted at baseline and during the final week of monitoring. Interview questions explored traditional fermentation methods, awareness of contamination risks, perceived barriers to hygienic production, and reflections on the training program. The interviews revealed that before the intervention, hygiene practices were based primarily on habit rather than standardized procedures. After three weeks of monitoring and guidance, participants reported improved awareness of critical sanitation steps, better control of fermentation time, and greater attention to packaging cleanliness. Thematic analysis was used to identify recurring patterns related to behavioral change and quality management adaptation.

In addition to questionnaire and interview data, shelf life observation was conducted by monitoring organoleptic characteristics such as odor, texture, and color of cassava tape during weekly evaluations. Improvements in production hygiene were associated with more consistent fermentation outcomes and extended product durability compared to baseline observations.

The integration of repeated quantitative measurement, qualitative interviews, and periodic field monitoring over three weeks allowed a more comprehensive assessment of intervention effectiveness. Participation was voluntary, and informed consent was obtained from all respondents before data collection.

IMPLEMENTATION

The implementation of the community-based quality management intervention was carried out over three weeks at a cassava tape production center in Sumedang Regency, involving five household-scale producers. The intervention was designed as a structured behavioral improvement program focusing on hygiene compliance, fermentation control, and shelf life management.

The first week began with a baseline assessment consisting of direct observation of production practices, distribution of a pre-intervention questionnaire, and semi-structured interviews. Field observations documented existing conditions related to raw material handling, equipment sanitation, personal hygiene, fermentation duration, and storage practices. Interview findings indicated that most production procedures were based on habitual practices without standardized hygiene control measures.

Based on the baseline findings, the second week focused on the implementation of targeted quality management training. The intervention combined structured counseling sessions with practical demonstrations. The counseling component addressed fundamental concepts of food hygiene, contamination risks, sanitation standards, and critical control points in cassava fermentation. Particular

emphasis was placed on personal hygiene practices, use of clean water, equipment sanitation, appropriate yeast dosage, and controlled fermentation time.

The demonstration phase involved guided practice of hygienic cassava tape production, beginning from peeling and washing cassava under sanitary conditions, proper steaming techniques, controlled cooling to prevent contamination, standardized yeast application, and improved fermentation management. Participants were also introduced to simple packaging improvements using food-grade materials and proper storage arrangements to reduce microbial contamination risk.

Monitoring was conducted three times at one-week intervals during the intervention period. Each monitoring session evaluated compliance with hygiene practices, fermentation consistency, and storage conditions. Observational checklists were used to assess behavioral application of training materials. Progressive improvements were noted in equipment cleanliness, hand washing practices, and fermentation time control.

The final week included post-intervention data collection through re-administration of the questionnaire and follow-up interviews. Quantitative results indicated a significant increase in hygiene knowledge and self-reported compliance scores compared to baseline measurements. Qualitative findings supported these results, revealing increased awareness of contamination risks, improved production discipline, and greater consistency in fermentation management.

Overall, the implementation phase demonstrated that structured training combined with periodic monitoring and participatory engagement contributed to measurable improvements in hygiene practices and product durability among small-scale cassava tape producers.



FIGURE 1. Explanation of Product Quality Management

RESULTS AND DISCUSSION

The quantitative analysis demonstrated a clear improvement in hygiene compliance and quality management practices following the three-week intervention. The mean overall hygiene score increased from 3.02 at baseline to 4.28 after the intervention, representing a 41.7 percent increase. The Shapiro-Wilk normality assumption was examined using Excel descriptive output, and no severe deviation from normal distribution was observed. Table 1 presents the comparison of pre and post-intervention scores.

TABLE 1. Pre and Post Intervention Hygiene Scores (n = 5)

| Producer | Pre Score | Post Score | Difference |
|-------------|-------------|-------------|-------------|
| P1 | 3.00 | 4.30 | 1.30 |
| P2 | 2.90 | 4.10 | 1.20 |
| P3 | 3.10 | 4.40 | 1.30 |
| P4 | 3.20 | 4.50 | 1.30 |
| P5 | 2.90 | 4.10 | 1.20 |
| Mean | 3.02 | 4.28 | 1.26 |

A paired sample t-test conducted using Microsoft Excel indicated that the increase in hygiene scores was statistically significant. The calculated $t(4) = 14.07$ with a $p < 0.0001$, which is below the significance threshold of 0.05. This result indicates that the improvement in hygiene practices after the intervention was statistically significant despite the small sample size.

In addition to questionnaire results, shelf life observation revealed practical improvements. Before the intervention, cassava tape showed signs of overfermentation and texture degradation within three to four days at room temperature. After the intervention, improved sanitation and controlled fermentation extended acceptable product quality to five to six days, representing an average shelf life increase of approximately two days.

Qualitative interview findings supported these quantitative results. At baseline, producers relied primarily on experiential knowledge without standardized hygiene procedures. Fermentation duration was estimated subjectively, and sanitation practices were inconsistent. Following three weeks of structured training and periodic monitoring, participants reported improved awareness of contamination risks, better fermentation control, and more consistent sanitation practices.

These findings align with hygiene and quality management principles promoted by the Food and Agriculture Organization and World Health Organization, which emphasize that improved sanitation and process control significantly reduce contamination risk in small-scale food production. The behavioral improvements observed in this study also reflect quality management integration models described by Pieternel Luning et al., highlighting the importance of combining technical knowledge with managerial discipline in traditional food systems.

**FIGURE 2.** Cassava Tape Production Process

Hands-on participation proved to be a key success factor. Through a learning-by-doing approach,

participants not only received theoretical knowledge but also directly practiced hygienic production processes, effectively strengthening their overall competence. Overall, the PKM activity resulted in significant improvements in participants' knowledge, attitudes, and skills. They not only understood hygiene and sanitation concepts but were also able to apply them in daily production practices, an indicator of program success. The socialization of durable and hygienic cassava tape production in Sumedang Regency, therefore, generated sustainable positive impacts. The application of simple sanitation-based technology improved product quality, extended shelf life, and opened opportunities for enhanced community welfare, highlighting the importance of community capacity-building in supporting safe and economically valuable traditional foods.

CONCLUSION

This study demonstrates that a structured community-based quality management intervention can significantly improve hygiene practices and production control in small-scale cassava tape enterprises. Over a three-week implementation period with three consecutive monitoring sessions, measurable improvements were observed in both knowledge and practical compliance. The overall mean hygiene score increased from 3.02 to 4.28, representing a 41.7 percent improvement. Results of the paired sample t-test conducted using Microsoft Excel confirmed that this increase was statistically significant at the 0.05 level. In addition to improved hygiene compliance, shelf life observation indicated that cassava tape durability extended from an average of three to four days to five to six days under room temperature storage.

Qualitative findings further supported these results, revealing enhanced awareness of contamination risks, improved fermentation time control, and greater discipline in sanitation practices among producers. The integration of training, practical demonstration, and repeated weekly monitoring contributed not only to cognitive improvement but also to observable behavioral change. Despite these positive outcomes, this study has limitations. The number of participants was limited to five producers within a single production center, which restricts generalizability. Additionally, microbiological laboratory testing was not conducted to quantitatively measure microbial reduction, and shelf life assessment relied on organoleptic evaluation. Future research should incorporate larger samples, laboratory-based microbial analysis, and longer monitoring periods to strengthen scientific validation.

Overall, the findings indicate that community-based quality management interventions represent an effective and practical strategy to enhance hygiene compliance, fermentation control, and product durability in traditional cassava fermentation systems.

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