

Community Empowerment through the Development of Instant Herbal Beverage from Butterfly Pea Flower Using Foam-Mat Drying Technique

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Abstrak

Inovasi produk pangan fungsional dari sumber daya alam lokal merupakan salah satu cara untuk mendorong kewirausahaan pedesaan dan mengatasi ketahanan pangan. Kegiatan pengabdian kepada masyarakat ini bertujuan untuk memberdayakan Kelompok Tani Kadugemblo melalui pengembangan minuman herbal instan dari bunga telang (*Clitoria ternatea*) dengan menggunakan metode pengeringan *foam-mat*. Program ini melibatkan 50 peserta dan terdiri atas kegiatan sosialisasi, pelatihan, demonstrasi, analisis sensori, serta pendampingan dalam *branding* dan pengemasan. Produk minuman fungsional, formulasi, konsep pengeringan, dan teknologi dievaluasi melalui *pre-test* dan *post-test* untuk mengukur peningkatan pengetahuan peserta. Nilai rata-rata *pre-test* sebesar 49,4%, sedangkan rata-rata *post-test* meningkat menjadi 97,8%, dengan peningkatan relatif sebesar 97,98%. Hasil ini menunjukkan bahwa pendekatan partisipatif dan pragmatis secara kuat memperkuat pengetahuan dan keterampilan petani dalam produksi minuman bubuk instan. Kegiatan ini juga meningkatkan pemahaman terhadap produk, karakteristiknya, pentingnya umur simpan, serta potensi pasar untuk minuman herbal fungsional. Studi kasus ini mencontohkan peran teknologi fungsional dalam mendorong pengembangan masyarakat dan pertumbuhan ekonomi pedesaan secara berkelanjutan.

Abstract

The innovation of functional food products from local natural resources is one way to promote rural entrepreneurship and address food security. This community service activity aimed to empower the Kelompok Tani Kadugemblo by developing instant herbal drinks from butterfly pea (*Clitoria ternatea*) using the foam mat drying method. This program reached 50 individuals and comprised socialization, training, demonstrations, sensory analysis, and support with branding and packaging. The functional beverages, formulation, drying, and technology concepts were assessed using a pre- and post-test surrounding the participants' knowledge. The mean pre-test score was 49.4%, while the post-test mean increased to 97.8%, resulting in a relative increase of 97.98%. These results indicate that the participatory and pragmatic approach strongly reinforced farmers' knowledge and skills in producing instant beverage powders. It also increased understanding of the product, its attributes, the importance of shelf life, and the potential market for functional herbal drinks. This case study exemplifies the role of functional technology in fostering sustainable community development and rural economic growth.



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INTRODUCTION

The development of empowered communities through constructive use of available natural resources helps sustain and improves social welfare and self-reliance even in remote areas. Empowerment means the processes that are designed to ensure that communities gain control of the decisions and resources that affect their lives. Many community level productivity and innovation enhancing programs in the agri-food domain have been designed around the concepts of empowerment, alongside, entrepreneurial training and technology integration (Lidder *et al.*, 2025). The Kelompok Tani

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Desa Kadugemblo farmer group in the Kadugemblo Village of Pandeglang Regency, Banten Province and its surrounding areas is still rural, but is endowed with significant capabilities in the development of agriculture and natural products. The group has been active in the cultivation and processing of local herbals and has recently come up with a line of herbal infusions made from butterfly pea (*Clitoria ternatea*), ginger (*Zingiber officinale*), lemongrass (*Cymbopogon citratus*), and lemon (*Citrus limon*). These products are sold as traditional health drinks at community events and local fairs. The infusions, however, are mainly available in liquid form, which not only limits their shelf life but also compromises their sensory characteristics. Thus, in order to improve product reliability and economic worth, the development of powder products is crucial. Butterfly pea (*Clitoria ternatea*) is a flower that is gaining scientific interest for being an ingredient rich in anthocyanins, flavonoids, and phenolic compounds due to its antioxidant, anti-inflammatory, and antimicrobial properties (Maia *et al.*, 2025). Another research has also noted that the anthocyanins in butterfly pea can tolerate thermal, further emphasizing its potential in beverage formulations as a natural colorant and bioactive ingredient. The mean value of the half-life of anthocyanin degradation at 60 °C is 19.7 h for fruits and 22.28 h for vegetables, and drastically decreased with increasing temperature, as deduced from several studies (Oancea, 2021). Moreover, a studied substantiated claims that *C. ternatea* extracts have antioxidant, antimicrobial, and neuroprotective properties, thus reinforcing its potential as a nutraceutical (Alias *et al.*, 2023). Innovative techniques such as green extraction that optimize the use of pigments and bioactive compounds using safe solvents have also been developed for functional foods (Irianto *et al.*, 2025). All this evidence further justifies using butterfly pea as the core functional ingredient, and the face, of beverages that promote natural color and health. Beverages based on indigenous herbs and spices, such as ginger, lemongrass, and butterfly pea, are nutritionally and sensorially beneficial as they contribute to the body's immune system and are natural antioxidants (V Y Pamela, 2021). Despite these pharmaceutical activities, the beverages are very perishable in their liquid state, which is why there is a need to develop associated instant powder products to improve their stability and improve the distribution range. Foam-mat drying is among the most suitable drying methods for producing heat sensitive instant drink powders because of the benefits it provides. Foam-mat drying is the drying of a stable foam layer at low temperatures forming a porous powder with good solubility and with low nutrient retention loss. This is possible studies proved that foam-mat drying is more effective than hot air drying since it enhances the drying kinetics and reduces the oxidation of bioactives while also providing the same sensory retention (Khatri *et al.*, 2024). Even more, foam-mat drying uses simpler and less energy while also retaining more polyphenols and antioxidants than spray drying (Kalambe, 2025). Crystallization drying as unappealing since it results in high sugar concentration solid granules which detracts from the healthy functional beverage. In addition, foam-mat drying as the simplest option, it is also the most economical (Kumar *et al.*, 2022). This is because it requires no complex and expensive equipment which is often out of reach for most community level producers, especially for those who want to dehydrate herbal extracts to form instant teas. More studies have also confirmed the application of foam-mat drying in the formulation of functional beverages. For instance, this study showed how changes in maltodextrin concentration and dextrose equivalent (DE) during the drying of foamed mats altered the physicochemical and probiotic profile of instant yogurt powder while preserving Lactic Acid Bacteria's viability and some attractive sensory characteristics (Eris *et al.*, 2023). These findings further support the use of the technique in functional beverage powder formulation and emphasize the need to retain important nutritional and sensory features. Therefore, the introduction of foam-mat drying to Kadugeblo village and other similar rural communities drastically changes the focus of knowledge dissemination. It improves the farmers' instructional abilities, promotes the sale of new products, and connects local businesses with scientific research. Also, other studies have shown that participatory training techniques improve the performance and adoption of new technologies among smallholder farmers (Shekhar *et al.*, 2025). In line with the background, this community service program was formulated to empower Kelompok Tani Desa Kadugemblo with technology and entrepreneurial training. The goals were to accelerate participants' knowledge and skills to produce instant butterfly pea herbal drink powder using the foam-mat drying method, increase understanding of product safety and quality, and augment commercialization through instrumental packaging and branding. This program is envisioned to be a pilot case of rural community empowerment through technology in functional food invention and rural sustainability.

METHOD

In Pandeglang Regency, Banten Province, the community empowerment program was operated from the village of Kadugemblo with the farmer group Desa Kadugemblo as the main partner of the community. The participants of this program which was held in August and September of the year 2025 included 50 local farmers and home industry workers most of whom were female processors of herbal raw materials. The program was crafted to enhance both technical and entrepreneurial skills and therefore was constructed in a workshop and entrepreneurial skills framework.

Implementation and Logistics

Having noted the problems, in the first place, the head of the village together with the head of the farmer group was to be contacted to select participants and check the availability of raw materials which include butterfly pea, ginger, lemongrass and lemon. In order to prepare for the level of knowledge pertaining to the production and the processing of herbal beverages, the knowledge of those who were surveyed should be controlled. Self-learning education textbooks, descriptive image books, and equipment for the practical demonstration of drying through foam mat were all assembled well in advance of the final date.

Socialization and Introduction of Functional Drink Concept

The first day of the training commenced with an interactive socialization session on functional beverages that covered their nutritional and economical importance and diversification opportunities for rural income generation. Participants were also acquainted with the principles of Good Manufacturing Practices (GMP) applicable for small-scale food processors, sanitary and hygiene requirements, and food engineering elements of maintaining the product quality and consumer confidence.

Training and Demonstration of Foam-Mat Drying Technique

The core of the preparation training was devoted to the practical demonstration of the foam-mat drying method for the production of instant herbal drink powders. Participants were coached on how to prepare the special herbal drink with a base of butterfly pea extract, and ginger and lemongrass powders, and acidulated with lemon juice, followed by incorporation of a stable foam prior to drying. The drying was carried out in a food dehydrator at 50 °C to retain the color and foldable foam. The foam sheet was then ground and sieved to get instant drink powder. Participants were taught and trained on the powder-packaging process and were instructed on the importance of hygiene, retention, and yield.

Evaluation of Sensory Attribute and Discussion of Quality of Product

To understand better the different attributes of quality of the product, the participants carried out sensory evaluation of the powder and the reconstituted drink produced. The parameters for evaluation were, color, aroma, flavour and acceptability in general. Conversations were held to correlate sensory analysis of different forms of the same product (e.g., forms with more ginger versus forms with more lemon). This phase within the workshop served also to help participants understand better the impact of the balance of the formulation and the consumers of the product.

Evaluation of the Knowledge with the Use of Pre and Post Tests

In order to find out the extent of improvement in appreciation of the subject, a structured test of the same set of questions – a pre test and a post test set were used on the participants prior to training and after training. The test comprised of ten questions that gauged the understanding of the ingredients, the principles of foam-mat drying, formulation and some other attributes that can be sensed. It was noteworthy that across all the questions, there was a tremendous improvement in the percentage of right answers, signifying that the participants were able to learn the concepts due to the fact that they were engaged in hands on training.

RESULT AND ACHIEVEMENT

Improvement in Knowledge

The community service activities, as with other components in the sponsored training program, significantly enhanced the participants knowledge on functional beverages and their manufacturing technologies. In this case, the participants

evidence of knowledge gain was gauged with the use of specific pre-test and post-test measures for training sessions (Figure 1). At the start, many participants did not understand one of the functional beverages, the drying technique used in them, and the formulation of the stable powders of beverages. With the participatory training workshops and the hands-on sessions, they achieved significant improvements in understanding. The training program recorded average pre-test scores of 49.4%, which was only limited to the recognition of basic elements. In this case almost all the post program average scores for the test was 97.8%, which meant an appreciation of improvement of 97.98%. There was improvement in all of the test items, especially those on the importance of butterfly pea as the source of antioxidants, foaming as a drying agent, and pH influence on color stability (Figure 2). The questions are :

1. Butterfly pea, lemongrass, and ginger can be processed into instant beverages.
2. Drying can extend the shelf life of products.
3. Drying can enhance the aroma of the ingredients.
4. Butterfly pea flowers can provide a natural blue color.
5. Lemon can change the blue color of butterfly pea to purple.
6. Ginger and lemongrass can impart a warming sensation.
7. Formulation will influence the taste and color of the instant beverage.
8. Instant beverages are produced through a drying process.
9. Instant beverages can be prepared simply by adding hot water.
10. Interested in trying instant butterfly pea and spice beverages.

The inclusion of lectures, discussions, and practical applications appears to have worked well. Participants learned much theoretical content and were also able to explain the benefits of foam-mat drying compared to sun drying, which discolors and microbiologically contaminates the dried product. The use of a participatory approach fostered active learning through doing, which was supplemented by question and answer sessions to clear up confusions about control of processes and product quality.



Figure 1. Pre test filling process.

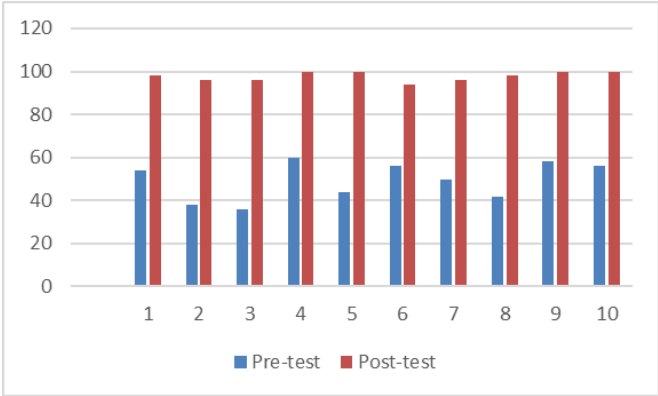


Figure 2. Percentage Recognitions for each Question.

Skill Development and Product Innovation

Besides gaining knowledge, the program achieved improvement in the participants' technical skills as well. They learned the processes of producing instant butterfly pea beverages through guided practice, which included extraction, foam formation, drying, grinding, sieving, and packaging. The training also showed how small-scale production could be done with simple, locally available tools optimized to replace more complex, sophisticated equipment. To lessen the moisture content without compromising the color and the antioxidants, the drying stage utilized a food dehydrator with a preset temperature of 50 °C for 3-4 hours, which was proven sufficient. The remainder of the solid product was shredded and pulverized to a fine mesh, and then filtered through a sieve of 100 mesh to obtain the desired texture which dissolves easily in water. The participants noticed the change of the liquid extract to powder and appreciated the significance of every advance made to enhance the solubility and the stability of the extract. The incorporation of the foaming and the stabilizing agents was a novelty for many of the participants. There was an understanding that Methocel® and Tween® are safe food foaming agents that enhance aeration and foam capacity, while xanthan gum and carrageenan are stabilizers that maintain bubble integrity during drying. The outcome was satisfactory, with the powders produced exhibiting deep vibrant blue to violet coloration, stubbornly aromatic, and rapidly soluble upon reconstitution. It delighted participants to realize that some of the scientific principles taught to them in school could be used in rural processing to improve the quality of the product and increase its market appeal. During the practical session, participants were given the opportunity to demonstrate their creativity, and they came up with two distinct product variants :

- 1) a warming and herbal profile of Butterfly pea-ginger-lemongrass,
- 2) and a refreshing, citrusy aroma of Butterfly pea-ginger-lemon.

Both were seen as functional marketable drinks that showcased the combination of local knowledge and technological advancement in the food and beverage sector.



Figure 3. Foaming Process.

Entrepreneurship and Branding

The program also aimed at building entrepreneurial thinking and business skills at the level of the farmer groups. They were lectured on the aspects of the marketing of food products, which include packaging, marketing, and quality control (Kusumasari *et al.*, 2022). The branding of the beverage focused on its being natural, its positive health impact of being rich in antioxidants, and its unique hue owing to the butterfly pea flower's anthocyanins. The branding focused on the

beverage's natural origin, antioxidant benefits, and color from butterfly pea anthocyanins (Figure 4). Mentoring sessions included a case study of the participants as a analyzing packaged herbal drinks available in the market. The participants were able to select the most successful aspects of the package: usability, moisture-proof closure, clear index, decorative design, and functional messages. They also learned to select the package which preserves moisture-proof and is also able to trap the flavor of the powder. During these sessions, participants understood the idea that a product is appreciated not only for its taste, but also for the arrangement of the testament as well as the testimony that the consumer is willing to give. Incomes remain unstable despite the fact that farmer products are still being marketed, thanks to the many participants that suggested setting up the community level venture to carry out production collaboratively under the "Desa Kadugemblo" brand. All the above suggestions are possible because the participants did not only receive the lectures but also trained in the principles of self-sustaining rural development to become innovative rural entrepreneurs.

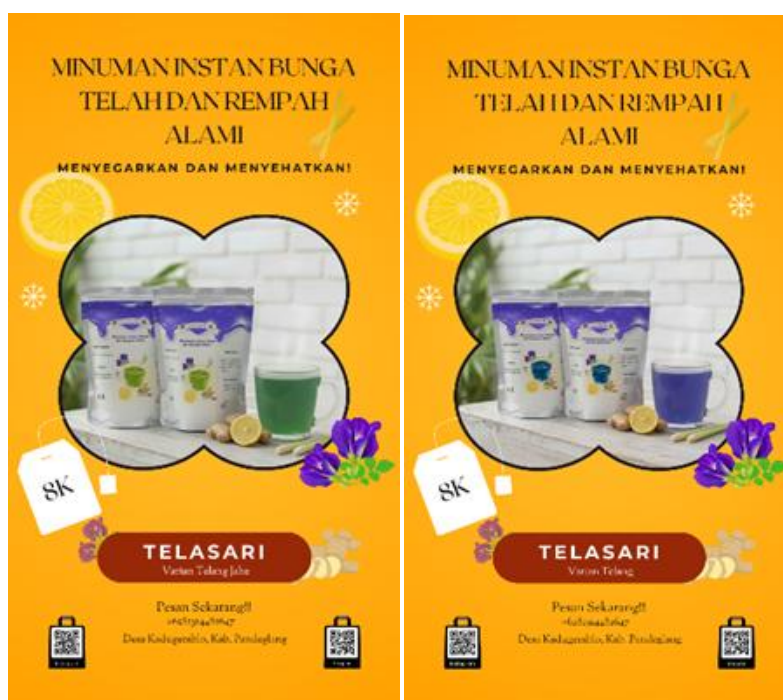


Figure 4. Branding herbal drink "Telasari".

Focus Group Discussion (FGD) on Sensory Evaluation

In the case of the last step, the FGD focused on reminiscence in order to evaluate the sensory features of the instant herbal drinks powder. The participants of the FGD engaged in design, learning and change activities individually and collectively and worked both as consumers and producers of the product. Members of the group added water to their product and started to evaluate different sensory parameters like colour, smell, taste, and the texture of the herbal drink (Figure 5). In the whole of the discussion, it appeared that the participants were happy to say that their final product (i.e. the drink) looked good, it smelled good and it tasted really nice. Most participants also said that the drink had a very nice aroma and it had a purple color that came from the butterfly pea, which really enhanced the drink and added to its health benefits as well as its nice appearance. People said that it had a very nice aroma and a smooth mouth feel which is very different from instant drinks that the participants said were usually available. Regarding the two variants, the lemon version was more popular for the color and brightness as well as the vibrant taste, while the lemongrass version was more popular because of the soothing and the more subtle, pleasant herbal scent. All participants from the two focus groups agreed that both formulations were appropriate for sale in the country as well as regionally. They also suggested, based on the focus group discussions, that the participants were Improvement of the fineness of the powder, the transparent wrapping to show the color, and clearer labeling on instructions were suggested and perceived to be increasing the acceptance of the consumers.

They also saw that the focus group discussions as a whole offered a sense of ownership to the participants. The focus group discussions also made the participants aware that sensory quality is crucial for the consumers and for the reputation of the product. It was shown that the session improved their skills of basic independent sensory evaluation. They were thus provided practical skills for improvement for the product and market strategies. The participants in the program perceived that increasing the level of knowledge possessed, improvement in skills of processing and fostering skills of innovativeness and entrepreneurship among the farmers were the goals of the program, which were met. The farmers had a unique opportunity that was a result of the application of science, incorporating the step by step participatory learning as well as the sensory evaluation. They had an opportunity to take advantage of business ideas that was based on empowering the community and sustainable technologies.



Figure 5. Sensory evaluation.

CONCLUSION

The community empowerment program carried out in Kadugemblo Village has successfully improved the knowledge and technical skill of Kelompok Tani through the use of foam-mat drying technology in the making of instant butterfly pea-based herbal drink. This particular activity not only deepened the knowledge of the participants on the functional beverage formulation but also improved their technical skills on extraction drying and packaging. The product produced also demonstrated good technical success and sensory acceptance because of the attractive color, good aroma, and excellent solubility. This program also explains how the introduction of local and inexpensive drying technology to foam-mat drying technology enhances local innovation and entrepreneurship in the rural area. This case also explains the positive impact of integration science-based participatory resource use training on the local resources and community. The program demonstrates the effectiveness of participatory resource use training on shifting the community to the use of functional products developed through the local resources.

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