From Job's Tears (*Coix lacryma-jobi* L.) to Tempeh

ABSTRACT

Moving tempeh development beyond soybean raises a practical question that fermentability alone does not settle: can a non-soy substrate be processed into a finished product that remains workable as tempeh under actual preparation conditions? This study addressed that question by developing job's tears (*Coix lacryma-jobi* L.) tempeh and comparing the final product with soybean tempeh in sensory terms. The work combined trial-based product development with paired sensory evaluation. Job's tears tempeh was refined through four successive trials, each revised in response to the weaknesses identified in the preceding stage. Once a workable product had been obtained, the final sample was evaluated against soybean tempeh by 20 panelists for texture, taste, aroma, and color, and the paired differences were analyzed using the Wilcoxon signed-rank test. The final trial yielded the most workable product, but significant paired differences remained across all four sensory attributes, with the largest mean gap found in aroma, followed by taste, texture, and color. The final product was descriptively characterized as moderately compact and slightly firm, mildly savory with a slight sour note, tempeh-like with a mild fermented note resembling *tape*, and white and fairly even across the surface. These findings show that job's tears can be developed into a workable tempeh product through process adaptation, even though the final product does not become a sensory equivalent of soybean tempeh.

Keywords: *Coix lacryma-jobi; non-soy tempeh; process adaptation*

Gladys Trifosa

Culinary Art Program

Politeknik Pariwisata Makassar

Lily Dianafitry Hasan

Culinary Art Program

Politeknik Pariwisata Makassar

Believe Imanuel Sanger

Culinary Art Program

Politeknik Pariwisata Makassar

Email: gladystrifosa@poltekparmakassar.ac.id

JOURNAL OF TOQUE & APRON

Volume	: 2
Number	: 1
Year	: 2026
Received	: Desember 5, 2025
Revised	: April 1, 2026
Accepted	: April 4, 2026
Published	: April 30, 2026

ISSN 2301-8593 (Online)
DOI : 10.33649/jta.v2i1.245

INTRODUCTION

Tempeh is still overwhelmingly understood through soybean. Soybean is not only its dominant substrate, but also the material that has long shaped expectations of what tempeh should look like, smell like, and feel like as a finished product (Górska et al., 2025; Teoh et al., 2024), once tempeh development moves beyond soybean, however, the issue becomes more demanding than simple fermentability. A different material may support fungal growth and still fail in the way that matters most in practice: it may not process into a finished product that holds together, can be handled properly, and remains recognizable as tempeh under actual preparation conditions (Fernandez Castaneda et al., 2025; Lücke et al., 2019; Stodolak et al., 2024; Wolkers – Rooijackers et al., 2018).

Job's tears makes that difficulty especially visible. As a cereal grain rather than a legume, *Coix lacryma-jobi* L. enters the tempeh-making process with a different kernel structure, hydration behavior, and cooking response than soybean (Igbokwe et al., 2022; Weng et al., 2022). Those material differences are not minor. They shape how the grains soften, how heat moves through them, and whether the substrate can reach the condition needed for coherent cake formation before fermentation proceeds further. Even where mycelial growth is possible, uneven hydration or incomplete softening may still leave the product physically unstable or difficult to handle (Ding et al., 2020, 2022). For that reason, job's tears is useful here precisely because it does not sit comfortably within soybean-based assumptions. It allows the study to ask what happens when a substrate is fermentable, yet materially resistant to the usual logic of tempeh preparation (Martín-Miguélez et al., 2025; Riyanto et al., 2025).

Work on tempeh and tempeh-like products from alternative substrates has already shown that soybean is not the only material capable of supporting *Rhizopus*-based fermentation. A range of grains, legumes, and other plant materials can enter that process under suitable conditions (Górska et al., 2025; Martín-Miguélez et al., 2025; Stodolak et al., 2024). What the literature shows less often, at least in comparable practical detail, is the developmental work that follows when the substrate does not respond well to soybean-oriented processing logic. Studies commonly establish feasibility, fermentation potential, or nutritional promise, but less often trace the sequence of revisions required when preparation, hydration, heat treatment, and handling repeatedly fail to produce a stable and usable tempeh product (Ahnan-Winarno et al., 2021; Teoh et al., 2024). That is where this study is situated. The problem was not simply whether job's tears could ferment, but what had to be changed when the material resisted straightforward transfer from soybean practice (Fernandez Castaneda et al., 2025; Kim et al., 2025; Villacrés & Rosell, 2021).

Seen from that angle, the gap is not only procedural. It is also about product realization. A non-soy substrate may undergo fermentation and still fall short as a finished product if it cannot be handled, portioned, or held together in a way that makes practical sense as tempeh. That is why product development and product realization are closely tied in this case. With job's tears, the more relevant question is whether repeated adjustments in preparation and processing can move the material beyond basic fermentability toward a form that is workable as tempeh, while also making clear whether the result remains distinct from soybean tempeh in sensory terms.

This study asked what it would take to turn job's tears into a usable tempeh product and how that final product would compare with soybean tempeh. Non-soy tempeh development was treated here not simply as a matter of whether fermentation could occur, but of whether a materially different substrate could be processed into a finished product that remained workable under practical conditions. The sensory component addressed the next question: once process refinement had produced a workable job's tears tempeh, did the final product still differ from soybean tempeh in texture, taste, aroma, and color?

METHOD

The study was structured in two linked stages: iterative product development and comparative sensory evaluation. No fixed final formula was established at the outset. Instead, job's tears tempeh was refined across successive trials, with each stage adjusted in response to the limitations observed in the preceding trial. After a workable product had been obtained for sensory assessment, it was evaluated and compared with soybean tempeh as the reference product. The design therefore linked stepwise process refinement with sensory comparison using soybean tempeh as the reference product.

Product development took place at Politeknik Pariwisata Makassar, Indonesia, in the Practical Kitchen Laboratory of the Culinary Arts Study Program. Sensory evaluation was conducted separately in the lobby area of the same laboratory. Job's tears (*Coix lacryma-jobi* L.) served as the non-soy substrate, whereas soybean tempeh was used as the reference product in the sensory comparison. Materials used across the trials included tempeh starter, rice flour, vinegar, banana leaves, perforated plastic, and water. Preparation, fermentation, and sample handling relied on routine kitchen equipment for washing, cooking, draining, wrapping, fermenting, slicing, and serving. During the sensory sessions, the experienced tempeh producers and sellers were assessed first, followed by the student consumer panelists in small groups, with the sessions staggered to accommodate the limited lobby space and avoid crowding.

Rather than following a fixed formula from the outset, the experimental product was developed through successive trials. The initial procedure drew broadly on conventional soybean tempeh processing, but it was modified as trial-specific weaknesses became apparent. Across the trials, the main adjustments involved soaking duration, boiling and steaming time, starter concentration, wrapping material, and the physical preparation of the grains. After each trial, the product was assessed for mycelial coverage, texture, aroma, and overall handling quality, and the next stage was revised in response to the most evident shortcomings. In this study, workable was used in a practical product-development sense rather than as an instrument-based or formally scored criterion. A trial outcome was considered sufficiently workable when the fermented mass showed enough mycelial binding to hold together as tempeh, did not remain excessively hard or become overly soft and unstable, did not develop an aroma so problematic that further evaluation became impractical, and could be handled and prepared for subsequent assessment without breaking apart too easily. These criteria served as the operational basis for judging whether a trial had moved beyond basic fermentability toward a product condition suitable for further refinement or, in the final stage, sensory evaluation. Previous studies on tempeh-type fermentation of alternative substrates have shown that pre-processing and thermal treatment often need to be tailored to the structural properties of the raw material, since direct transfer of soybean-based steps can lead to uneven hydration, inconsistent softening, and unstable cake formation (Lücke et al., 2019). Studies tracking fermentation dynamics in non-soy matrices likewise suggest that substrate-specific handling, rather than fermentation

alone, often determines whether a material becomes technically workable during solid-state fermentation (Stodolak et al., 2024; Villacrés & Rosell, 2021).

A standardized baseline formulation was used at the outset of development to provide a controlled point of departure for both soybean and job's tears tempeh. This initial formula remained broadly aligned with conventional soybean tempeh practice and used a starter level of 0.1%–0.2% (w/w, dry-substrate basis), a range commonly reported for commercial tempeh starters in Indonesian practice (Agista et al., 2024; Rizal et al., 2024). The same inoculation range was applied to both substrates not to assume identical fermentation behavior, but to establish a comparable starting condition for the early-stage trials. Later modifications were introduced in response to the processing behavior of job's tears during product development.

Table 1

Standardized Baseline Formula Used in the Initial Development Stage of Soybean and Job's Tears Tempeh

Product	Standardized Batch Basis	Ingredient	Formula (%)	Metric Quantity	Function in the Initial Formulation
Soybean tempeh	200 g dry-substrate basis	Soybeans	100.0	200 g	Soybean substrate used as the baseline reference in the initial formulation stage
Soybean tempeh	200 g dry-substrate basis	Tempeh starter	0.1–0.2	0.2–0.4 g	Initial inoculation range used as the baseline starter level
Job's tears tempeh	200 g dry-substrate basis	Job's tears	100.0	200 g	Non-soy substrate used in the initial development stage
Job's tears tempeh	200 g dry-substrate basis	Tempeh starter	0.1–0.2	0.2–0.4 g	Initial starter range aligned with the soybean baseline before later trial-based adjustment

Note. The baseline formulation is reported on a standardized 200 g dry-substrate basis to support consistent recipe reporting across substrates. Formula percentages are expressed on a w/w dry-substrate basis. The baseline starter range was used to anchor early-stage development, while subsequent trials revised processing parameters in response to substrate-specific behavior.

At the baseline stage, the initial formula was implemented through a standard working sequence consistent with the basic logic of tempeh preparation, before any later trial-based adjustments were introduced. Based on the dry-substrate formulation shown in Table 1, the baseline procedure was carried out as follows:

1. The dry substrate was weighed according to the baseline formulation, and the tempeh starter was weighed separately according to the 0.1%–0.2% inoculation range.
2. The substrate was washed twice to remove adhering dirt and surface impurities.
3. The washed substrate was soaked for approximately 16 h to allow hydration before heat treatment.
4. After soaking, the substrate was drained and briefly steamed for approximately 5 min.
5. The heated substrate was spread out and cooled to room temperature while still slightly moist.
6. The starter was added only after cooling, and the substrate was mixed until the inoculum was distributed as evenly as possible.
7. The inoculated substrate was packed in perforated plastic to allow air exchange during fermentation.

8. The packaged material was fermented under covered conditions in a switched-off oven used as a closed fermentation chamber in an unlit (inactive) oven.
9. During fermentation, the product was checked periodically to document mycelial coverage, texture development, aroma development, and overall product condition.

The sensory stage was kept intentionally small. At this point, the aim was not to estimate broad consumer preference, but to examine how the final job's tears tempeh compared with soybean tempeh on four specific attributes: texture, taste, aroma, and color. The panel therefore comprised 20 participants and functioned as an exploratory assessment rather than a large-scale acceptance test, consistent with sensory-method literature showing that panel size and panel composition should follow the purpose of the evaluation rather than a single fixed rule (Drake et al., 2023; Ruiz-Capillas & Herrero, 2021). The panel was assembled purposively. Five participants were experienced tempeh producers and sellers, included because they were already familiar with the sensory character of tempeh as a fermented product. The other 15 were student consumer panelists from the Culinary Arts Study Program, included to capture responses closer to those of likely end users in a culinary education context. This combination brought product-familiar judgment and consumer-oriented response into the same exploratory assessment, reflecting the distinction commonly made in sensory methodology between product-oriented and consumer-oriented roles (Marques et al., 2022; Ruiz-Capillas & Herrero, 2021). Each panelist evaluated both job's tears tempeh and soybean tempeh, with the two samples presented simultaneously in the same evaluation round and in the same order for all panelists. Because the available space was limited, the assessment was conducted in staggered sessions rather than in a single sitting. The responses were analyzed as one exploratory paired dataset because the purpose of the sensory stage was to compare the two products within a small product-development study rather than to compare responses between panel subgroups. These design choices suited the exploratory aim of the study, but they also limit how far the sensory results should be interpreted beyond the conditions used here.

The sensory data were analyzed in two stages using IBM SPSS Statistics 31. First, the rating-scale responses for texture, taste, aroma, and color were summarized descriptively and then compared between job's tears tempeh and soybean tempeh. Because both products were evaluated by the same panelists in the same assessment round, the data were treated as paired observations. Given that the responses were collected on a 4-point rating scale, the difference between the two products for each attribute was tested using the Wilcoxon signed-rank test, which is appropriate for paired comparisons when the analysis is based on matched observations and the response scale does not justify a stronger parametric assumption (Ranganathan, 2021). Statistical significance was interpreted at $p < .05$. Second, the category-based descriptive responses were tabulated by frequency to identify the dominant sensory description selected for each attribute of the final job's tears tempeh. This combination of paired comparison and frequency-based description was used to show both the direction of the difference between the two products and the dominant descriptive profile of the final product.

RESULTS

Process Refinement Across Four Trials

The development of job's tears tempeh proceeded through four iterative trials, and each trial introduced clear process changes in response to the weaknesses identified in the preceding stage. Trial I showed that a soybean-tempeh-oriented method did not produce a satisfactory result, as the grains remained sandy and undercooked and the product developed a sharply sour, pungent aroma. Trial II improved softness and accelerated fungal growth, especially in the banana-leaf-wrapped samples, but sour taste and aroma remained strong. Trial III produced a more tempeh-like appearance, yet product quality still varied across wrapping treatments, with plastic-wrapped samples remaining soft and slightly sticky and banana-leaf-wrapped samples still containing some firmer grains. The strongest process outcome was achieved in Trial IV, where the grains were crushed into coarse pieces, soaking and steaming were removed, and the substrate was boiled briefly before fermentation. Compared with the earlier trials, this final process most clearly met the study's practical basis of workability: the fermented mass held together more cohesively, no longer remained hard, sandy, or overly soft, and no longer showed the severe aroma problem that had repeatedly limited further evaluation. For that reason, Trial IV was selected as the final process and used to produce the sample for sensory evaluation.

Table 2

Process Refinement Across Four Trials in the Development of Job's Tears Tempeh

Trial	Key Process Changes	Main Outcome and Problem	Basis for Refinement
Trial I	The grains were washed twice, soaked for 16 h, steamed for 5 min, inoculated with 0.2% starter, wrapped in perforated plastic, and fermented in an inactive oven.	By the third day, fungal growth had covered the surface and the product visually resembled soybean tempeh. However, the texture remained sandy and undercooked, and the aroma was sharply sour and pungent.	Greater grain softening and a revised cooking approach were required to improve texture and reduce the excessive sour aroma.
Trial II	The soaking stage was reduced to 2 h, followed by boiling for 25 min and steaming for 40 min. Perforated plastic and banana-leaf wrapping were both tested.	Texture improved and fungal growth appeared faster than in Trial I. Banana-leaf-wrapped samples showed denser growth, but sour aroma and sour taste remained strong.	The next trial focused on reducing sourness, lowering the starter level, and re-evaluating the role of wrapping material in fermentation performance.
Trial III	The grains were boiled for 1 h and steamed for 40 min. The starter level was reduced to 0.1%, and perforated plastic and banana-leaf wrapping were again compared.	Both treatments produced a more tempeh-like appearance. Plastic-wrapped samples remained soft and slightly sticky, whereas banana-leaf-wrapped samples still contained some firmer grains. Sour-sweet aromatic notes persisted.	Further refinement was required to improve structural uniformity, reduce moisture-related inconsistency, and obtain a more stable sensory profile.
Trial IV	Job's tears were crushed into coarse pieces, washed three times, boiled for 10 min, and mixed with starter and rice flour, with vinegar added before fermentation.	By the second day, fungal growth had covered the surface, and the product no longer showed the texture and aroma problems that dominated the earlier trials. The	Trial IV most closely met the study's operational basis of workability and was therefore selected as

	Steaming was removed. The product was wrapped in perforated plastic and fermented for 48 h in an inactive oven.	tempeh was no longer hard, sandy, or overly soft, although a slight sour note and some starter aroma remained.	the final process for sensory evaluation.

Note. This table summarizes the stepwise refinement of the processing method across four trials and shows how the limitations identified in each trial informed the modifications introduced in the next trial.

Sensory Differences Between Job's Tears Tempeh and Soybean Tempeh

Sensory evaluation showed significant paired differences between job's tears tempeh and soybean tempeh across all four assessed sensory attributes. For every attribute, soybean tempeh received a higher mean score than job's tears tempeh. The largest mean gap appeared in aroma, followed by taste, texture, and color. These results indicate that, although Trial IV yielded a workable job's tears tempeh product, its sensory profile remained significantly distinct from that of soybean tempeh.

Table 3

Paired Sensory Comparison Between Job's Tears Tempeh and Soybean Tempeh

Attribute	Mean Score (Job's Tears Tempeh)	Mean Score (Soybean Tempeh)	Mean Difference	*p* Value (Two-Tailed)	Interpretation
Texture	3.00	3.65	0.65	0.000311	Significantly different
Taste	2.85	3.65	0.80	0.000162	Significantly different
Aroma	2.60	3.50	0.90	0.000057	Significantly different
Color	3.20	3.80	0.60	0.000532	Significantly different

Note. Comparisons were calculated from paired observations because the same 20 panelists evaluated both products. *p* values were obtained using the Wilcoxon signed-rank test.

Aroma produced the widest separation between the two products, with a mean difference of 0.90 points. Taste showed the next largest difference at 0.80, followed by texture at 0.65 and color at 0.60. The direction of the difference was consistent across all four attributes, with soybean tempeh receiving higher scores in every case. Taken together, these results show a stable paired pattern in which job's tears tempeh scored lower than soybean tempeh across the full set of assessed sensory attributes.

Dominant Descriptive Sensory Profile of the Final Product

The final job's tears tempeh showed a distinct descriptive sensory profile. In terms of texture, the dominant response characterized the product as moderately compact and slightly firm. In terms of taste, it was most frequently described as mildly savory with a slight sour note. Its aroma was described as tempeh-like, with a mild fermented note resembling tape—a traditional Indonesian fermented cassava product. Its color was identified as white and fairly even across the surface. Taken together, these responses indicate that the final product had developed a more tempered sensory profile than the earlier trials, while still remaining distinguishable from soybean tempeh.

Panelist agreement varied across the assessed attributes. Taste showed the highest level of agreement, with 15 of the 20 panelists reflecting the same dominant response tendency. Color followed with 14 panelists, while texture and aroma showed lower concentration, with

the dominant response reflected by 12 panelists in each case. This pattern indicates that taste and color were read more consistently by the panelists, whereas texture and aroma remained somewhat more varied in the descriptive evaluation.

Table 4

Dominant Descriptive Sensory Profile of the Final Job's Tears Tempeh

Attribute	Dominant Descriptor	Panelists Reflecting the Dominant Response Tendency (*n* = 20)
Texture	Moderately compact and slightly firm	12
Taste	Mildly savory with a slight sour note	15
Aroma	Tempeh-like, with a mild fermented note resembling *tape*	12
Color	White and fairly even across the surface	14

Note. For each attribute, the dominant descriptor refers to the response category selected most frequently by the panelists in the descriptive sensory evaluation.

DISCUSSION

Across the four trials, one point became clear: job's tears could not be developed into a workable tempeh product simply by transferring a conventional soybean-tempeh procedure to a different substrate. In the early trials, mycelial growth became visible across the surface, but that apparent success did not resolve the recurring problems of texture and aroma. The grains remained difficult to cook evenly, and the product repeatedly developed sour and pungent notes rather than moving toward a stable tempeh-like sensory profile. A turning point emerged only when the process was reorganized around the handling requirements of the substrate itself. Once the grains were crushed into coarse pieces, soaking and steaming were eliminated, and boiling was shortened before fermentation, the final product showed better cohesion and fewer of the structural weaknesses seen in the earlier trials. Viewed in this way, the study shows more than the fact that job's tears can be fermented. A workable product emerged only after the process was adapted to the material's own processing characteristics, rather than treated as a direct procedural copy of soybean tempeh (Drabo et al., 2023; Fernandez Castaneda et al., 2024).

What appears to have mattered most in this shift was not fermentation alone, but the way the substrate was physically prepared before fermentation began. In the earlier trials, the repeated sequence of soaking, boiling, and steaming did not yield a stable substrate condition. Some grains still remained firm, while others became softer or slightly sticky as fermentation progressed. Crushing the grains into coarse pieces may have altered that balance by making the material easier to cook more evenly in a shorter boiling stage, without continued reliance on prolonged hydration before inoculation. Under the conditions used here, that modification was associated with a better balance of softness, cohesion, and surface conditions for fungal growth. Similar observations have been reported in the development of non-soy tempeh, where hydration, thermal treatment, and pre-processing often need to be adjusted to the physical characteristics of the raw material rather than copied directly from soybean-based practice (Fernandez Castaneda et al., 2024, 2025; Kim et al., 2025; Thulesen et al., 2025).

The sensory comparison indicates that process adaptation and sensory equivalence were not the same achievement in this study. Trial IV resolved the structural problems that had dominated the earlier trials, but it did not eliminate the sensory differences between job's tears tempeh and soybean tempeh. Aroma remained the clearest point of separation, followed by taste, while texture and color also received lower scores than soybean tempeh. This pattern suggests that the revised process succeeded primarily in making the product workable as tempeh—fermentable, cohesive, and usable—rather than in reproducing the sensory profile of soybean tempeh itself. Similar distinctions have been reported in the development of non-soy tempeh, where process adjustment can improve product workability while the sensory consequences of using a different raw material remain evident (Erkan et al., 2020; Fernandez Castaneda et al., 2025). In that sense, the final product is better understood as a workable job's tears tempeh with its own sensory identity than as a direct sensory equivalent of soybean tempeh (Drabo et al., 2023; Erkan et al., 2020; Fernandez Castaneda et al., 2025).

The descriptive profile of the final product helps clarify why the sensory gap with soybean tempeh persisted even after the process had become workable. The final trial resolved the most serious process-related problems seen in the earlier stages, but it did not make job's tears behave like soybean during fermentation or in the finished product. That difference remained visible in a more moderated form. The texture was no longer read as clearly loose or hard, but as moderately compact and slightly firm, which suggests that structural coherence had improved without fully converging on the more familiar body of soybean tempeh. The taste profile also shifted toward a milder expression, with a slightly savory character and only a slight sour note, while the aroma retained a tempeh-like character with a mild fermented note resembling tape. The color moved in the same direction, being read as white and fairly even across the surface rather than markedly uneven. Taken together, these responses suggest that the final trial did not simply make the product fermentable; it also moved the sensory outcome toward a more stable and acceptable profile. Even so, the paired comparison still showed that the final product remained distinct from soybean tempeh, which suggests that process improvement reduced but did not erase the sensory consequences of using a different substrate. Similar observations have been reported in the development of non-soy tempeh and tempeh-like products, where process optimization improves cake formation and handling while substrate-linked sensory differences remain evident (Ahnan-Winarno et al., 2021; Erkan et al., 2020; Kim et al., 2025).

What emerged from these trials was not a soybean substitute, but a workable way of making tempeh from job's tears on its own terms. Similar concerns have been raised in studies of non-soy tempeh and tempeh-like products, where successful fermentation depends on adjusting hydration, heat treatment, and pre-processing to the physical characteristics of the raw material rather than transferring soybean-based procedures unchanged (Wolkers – Rooijackers et al., 2018; Wu et al., 2022). The point is not that job's tears can reproduce soybean tempeh once fermentation is achieved. What these trials

suggest instead is that a workable product can emerge when the process is reorganized around the material's own handling requirements, even if the resulting sensory profile remains distinct from soybean tempeh. From that perspective, non-soy tempeh development is more usefully judged by product viability, process fit, and the emergence of a defensible sensory identity than by direct equivalence to soybean tempeh.

What the study can claim is shaped by the evidence it collected. The process was refined through four trials, but the final product was evaluated only through sensory assessment, so the analysis cannot explain the physicochemical basis of the remaining differences in texture, aroma, and color. The work also followed only one final processing route for job's tears and compared it with only one reference product, soybean tempeh. The findings are therefore specific to the fermentation and handling conditions used here rather than readily generalizable to other non-soy substrates or processing variants. The sensory evaluation was also relatively narrow in scope: it involved 20 panelists—5 experienced tempeh producers and sellers and 15 student consumer panelists—and relied on a 4-point rating scale and category-based descriptive responses rather than instrumental analysis or a broader consumer test. In addition, both products were presented simultaneously and in the same order to all panelists, and the combined sensory dataset drew on respondents with different forms of familiarity with tempeh. These choices suited the exploratory product-development purpose of the study, but they also limit how far the sensory differences should be generalized beyond this small paired assessment. The study therefore speaks most clearly to product development and perceived sensory outcome, and less clearly to the mechanisms underlying them.

CONCLUSION

Job's tears only became workable as tempeh once the process no longer treated soybean as the default model. The final product did not emerge from carrying over a standard soybean-tempeh procedure unchanged, but from successive process adjustments that reshaped substrate preparation and cooking until the material fermented into a cohesive product suitable for sensory evaluation. Even so, that process adaptation did not eliminate the sensory distance from soybean tempeh. Significant differences remained in texture, taste, aroma, and color, and the descriptive profile continued to reflect the sensory character of job's tears itself. The study's contribution lies in showing that a non-soy substrate can be made workable as tempeh through process adaptation, even when the finished product does not become a sensory equivalent of soybean tempeh.

The next question is no longer whether job's tears can be made into tempeh, but why the finished product remained distinct from soybean tempeh after the process had become workable. Answering that question will require more than sensory assessment alone. Future work could examine a wider range of processing variants, incorporate instrumental and compositional analyses, and evaluate the product under broader sensory conditions, including larger consumer panels and repeated production across batches. That next step matters because job's tears tempeh needs to be understood not only as a workable fermented

product under the conditions used here, but also as a substrate with a more clearly defined processing window and more identifiable quality limits.

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