Indonesian Journal of Multidisciplinary on Social and Technology
Homepage: https://journal.ilmudata.co.id/index.php/ijmst
Vol. 4 No. 3 (2026) pp: 3481-3488
P-ISSN: 2986-6790, e-ISSN: 2986-6782

Does Downstreaming Create Value the Market Can See? A Blind Discrimination Test of Fermented Versus Unfermented Cocoa Nibs Among Food and Beverage Buyers

Rizky Abdilah[1*], Siti Balqis[2], M Febry Hardiansyah[3], Muhammad Rafli[4]
[1]Faculty of Communication and Diplomacy, Universitas Pertamina, Jakarta
[2]Faculty of Economics and Business, Telkom University, Bandung
[2]Faculty of Law, University of Syiah Kuala, Banda Aceh
[4]Faculty of Agriculture, University of Samudera, Langsa
rabdilah1207@gmail.com

Abstract

Downstreaming (hilirisasi) is a central pillar of Indonesian industrial policy and is increasingly applied to agricultural commodities at the village level. This study examines whether value added through cocoa fermentation can be detected by potential buyers and translated into demand. Cocoa nibs from a single farm and harvest lot were divided into fermented and unfermented portions, then roasted and winnowed identically. Twenty-five food and beverage businesses in Aceh Tamiang—15 coffee shops, 5 bakeries, and 5 micro cocoa enterprises—received both samples blindly in coded containers and were asked to identify the fermented sample. All respondents identified it correctly ($p < 0.001$), with a 95% confidence interval for the underlying detection rate of 86.3–100%. Identification was primarily attributed to the fermented sample's sweeter taste, stronger aroma, and drier texture. Detection translated into purchase among 15 outlets (60%). However, demand modeling based on observed offtake indicates that all 25 outlets would absorb only approximately 5.6 tons of dry beans annually, equivalent to about 3% of the cocoa volume currently sold unfermented in the regency. The findings confirm that fermentation creates detectable quality value but demonstrate that processing capacity alone is insufficient. Without deliberate market expansion beyond local channels, downstreaming can validate quality without generating sufficient market absorption.

Kata kunci: *Downstreaming; Value Addition; Blind Discrimination Test; Organisational Buying; Cocoa.*

1. Introduction

Downstreaming has become a defining theme of Indonesian economic policy. Originally applied to mineral commodities, the logic has been extended to agriculture and increasingly to village-scale processing, on the reasoning that a country exporting raw material forfeits the value added further along the chain (Hasibuan & Sayekti, 2018). For cocoa the argument is compelling on its face. Only around five percent of Indonesian cocoa is fermented (Abubakar, 2017), so the overwhelming majority of beans leave the farm as undifferentiated bulk and attract automatic quality discounts, and fermentation is the post-harvest step that would convert them into a differentiated product.

The policy nonetheless rests on a premise that is seldom examined. Downstreaming creates value only if the value it creates is perceptible to the buyer who must pay for it. Processing capacity does not by itself generate a premium; a premium exists only where a buyer can distinguish the processed product from the unprocessed one and is willing to pay the difference. Where the distinction is invisible to the market, investment in processing produces cost without revenue. This premise is rarely tested because it is usually assumed, and because testing it requires isolating the processing step from every other source of product difference.

Isolation is methodologically demanding. Studies comparing commercial products cannot attribute differences to processing because origin, formulation, packaging and brand equity are confounded. Information effects compound the problem: once a buyer is told which sample has been processed, the response measures belief about processing rather than perception of it, and expectation alone is known to shape sensory judgement (Deliza & MacFie, 1996). A credible test therefore requires both a controlled stimulus and blind presentation.

This study supplies both. Cocoa nibs were produced from a single farm and a single harvest lot, split so that one portion was fermented and the other was not, then dried, roasted and winnowed under identical conditions, so that fermentation is the only systematic difference between the samples. The samples were presented blind to the decision-makers of twenty-five food and beverage businesses, who were not told which sample was which and were asked to identify the fermented one. The design is a two-alternative forced-choice discrimination test, the standard instrument in sensory science for establishing whether two products are distinguishable at all (Lawless & Heymann, 2010).

Framing the question as discrimination rather than preference is deliberate and consequential. A preference test establishes that buyers like one product more; a discrimination test establishes the logically prior fact that they can tell the products apart. For downstreaming policy the prior fact is the binding one, because a difference that cannot be detected cannot be priced regardless of how attractive it might be if noticed.

Three objectives follow. The first is to test whether professional food and beverage buyers can detect the difference fermentation makes under blind conditions. The second is to establish whether detection translates into purchase. The third is to assess how much volume the channel can absorb, and therefore whether detectability alone is sufficient to justify downstreaming investment at village scale.

2. Method

Design and Location

The research is a quantitative descriptive study employing a blind two-alternative forced-choice discrimination test followed by observation of purchase behaviour. It was conducted in Aceh Tamiang Regency, Aceh Province, between August and October 2025, in cooperation with a local cocoa aggregator.

Units of Analysis and Frame

The unit of analysis is the business rather than the individual consumer, and the evaluation at each site was performed by the person responsible for menu and procurement decisions. Twenty-five food and beverage businesses were included, selected purposively as established buyers of the type that would plausibly purchase differentiated cocoa. The frame comprises fifteen coffee shops, five bakeries and five micro cocoa enterprises. Including three segments is deliberate, because their end uses differ: coffee shops deploy nibs mainly in beverages, bakeries in baked applications, and micro enterprises in small-batch products. Agreement across all three would indicate that detectability does not depend on one preparation method.

Stimulus Preparation

Cocoa beans were drawn from a single farm and a single harvest lot and divided into two portions. One portion was box-fermented and then dried; the other was dried directly without fermentation. Both were subsequently dried to comparable moisture, roasted under an identical profile and winnowed into nibs using the same equipment. Fermentation is therefore the only systematic difference. Nibs were selected as the test format because they present cocoa flavour with minimal formulation masking.

Procedure and Analysis

Both samples were delivered to each site in unmarked containers identified only by code, with presentation order varied. Evaluators were asked to identify which sample had been fermented and to state the reasons for their judgement. Purchase behaviour following the visit was recorded from the aggregator's sales records. Because the outcome is a binary forced choice with a guessing probability of one half, the exact binomial test is the appropriate inferential procedure, applied one-sided as is standard for discrimination designs, with the Clopper-Pearson method used for interval estimation. The test was repeated within each segment as a consistency check.

$$H0 : p = 0.5 \quad against \quad H1 : p > 0.5 \qquad (1)$$

DOI: https://doi.org/10.69693/ijmst.v4i2.13879
Lisensi: Creative Commons Attribution 4.0 International (CC BY 4.0)

3. Result & Discussion

1. Frame

All twenty-five businesses approached completed the evaluation, a response rate of one hundred percent attributable to the in-person sampling method, which delivered product directly rather than relying on questionnaire return (Table 1).

Table 1. Sample frame by segment

Segment	n	Share	Principal end use
Coffee shop	15	60.0%	Beverages
Bakery	5	20.0%	Baked goods
UMKM kakao (micro)	5	20.0%	Small-batch products
Total	25	100%	Three end uses

Source: primary data, 2025

2. Discrimination Result

All twenty-five businesses correctly identified the fermented sample. Table 2 reports the exact binomial test.

Table 2. Exact binomial test of blind identification

Statistic	Value	Interpretation
Correct identifications	25 of 25	100%
Incorrect	0 of 25	0%
Null hypothesis	$p = 0.50$	Guessing
Exact binomial p (one-sided)	2.98×10^{-8}	$p < 0.001$
95% CI (Clopper-Pearson)	86.3%–100%	H1 accepted
Upper bound, failure rate	12.0%	Rule of three

Source: processed data, 2025

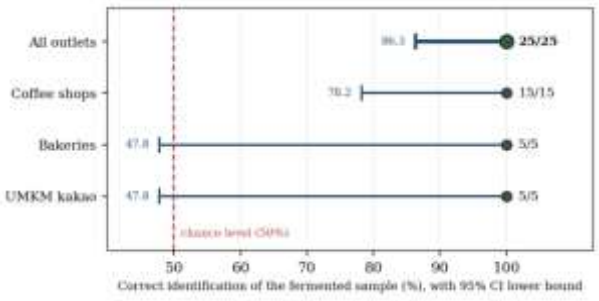

Figure 2. Correct identification by segment, with 95% confidence bounds
Source: processed data, 2025

DOI: https://doi.org/10.69693/ijmst.v4i2.13879
Lisensi: Creative Commons Attribution 4.0 International (CC BY 4.0)

The probability of twenty-five consecutive correct identifications arising by guessing is approximately one in thirty-three million, so H1 is accepted. The Clopper-Pearson interval places the underlying detection rate at no less than 86.3 percent among comparable buyers, and the rule of three bounds the failure rate below twelve percent with ninety-five percent confidence. Because evaluators were not told which sample was fermented, nor that fermentation was the variable under study, the result cannot be attributed to expectation, label effects or acquiescence bias.

Table 3 repeats the test within segments. The coffee shop subgroup is independently significant, while the two five-outlet segments reach significance one-sided but are individually weak and should be read as directionally consistent rather than as independent confirmations. What matters is that no segment departs from the pattern: detectability holds across beverage, baked and small-batch applications, indicating that the quality signal is intrinsic to the ingredient rather than specific to one preparation method.

Table 3. Segment consistency

Segment	Result	Exact p	95% CI low
Coffee shops	15/15	3.05×10^{-5}	78.2%
Bakeries	5/5	0.031	47.8%
UMKM kakao	5/5	0.031	47.8%
All outlets	25/25	2.98×10^{-8}	86.3%

Source: processed data, 2025. One-sided exact binomial tests.

3. Attributes Cited

Evaluators were asked to state the basis for their identification. Three characteristics of the fermented sample recurred across the twenty-five sites, listed in Table 4. Because respondents volunteered these in open comment rather than selecting from a prompted list, they are reported as recurring themes rather than as frequencies.

Table 4. Characteristics of the fermented sample cited by evaluators

Attribute	Sensory channel	Underlying mechanism
Sweeter taste	Gustatory	Reduced bitterness and astringency
Stronger aroma	Olfactory	Maillard precursors formed
Drier texture	Tactile	Pulp breakdown, better moisture release

Source: primary data, 2025; mechanisms from the cited literature

All three descriptions correspond to documented consequences of fermentation, which is notable because the evaluators were not told what distinguished the samples and are not sensory scientists. The reported sweetness is unlikely to be sweetness in the strict sense, since neither sample contained added sugar. It is more plausibly the perceptual consequence of reduced bitterness and astringency: fermentation degrades the polyphenols responsible for those sensations, and their removal is commonly experienced as increased sweetness (Wollgast & Anklam, 2000). This interpretation is consistent with evidence that preference for chocolate drinks falls as unfermented

DOI: https://doi.org/10.69693/ijmst.v4i2.13879
Lisensi: Creative Commons Attribution 4.0 International (CC BY 4.0)

powder is substituted in, driven specifically by bitter taste and bitter aftertaste (Ramadhan et al., 2021). The stronger aroma corresponds directly to the formation of amino-acid precursors that generate chocolate aroma during roasting (Afoakwa et al., 2008; Ardhana & Fleet, 2003; Rohan, 1964), and the drier texture reflects the breakdown of adhering pulp during fermentation, which allows more complete moisture release in drying and yields a more friable nib.

That professional buyers independently reproduced the biochemical account in ordinary commercial language is a strong form of construct validation. It also indicates that the difference is not a marginal technical nuance detectable only under laboratory conditions, but a coarse difference apparent to anyone who handles and tastes the product.

The mix of sensory channels carries a practical implication for downstreaming operations. Aroma and taste require tasting, which is why direct sampling achieved complete engagement where a questionnaire would likely have failed and why a marketing budget should be treated as part of the processing investment rather than as discretionary overhead. Texture, however, is perceptible on handling alone, which offers buyers and intake graders a rapid proxy check that does not require preparation. Where formal grading capacity is absent, this provides a low-cost first filter at the point of purchase.

4. From Detection to Purchase

Detection establishes that a premium is possible; it does not establish that one will be paid. The stronger test is whether evaluating businesses subsequently committed budget. Fifteen of the twenty-five outlets agreed to purchase following the blind test, a conversion rate of sixty percent, with a 95 percent confidence interval of 38.7 to 78.9 percent. The largest outlet reached a steady offtake in the range of fifteen to twenty kilograms per month, which serves as the calibration benchmark below.

H2 is accepted. A conversion rate of three in five from a single unsolicited sampling visit is high for business-to-business acquisition, and it is attributable to the nature of the product rather than to the selling effort: an experience attribute that the buyer can verify immediately requires no trust in the seller's claims (Nelson, 1970). The evidence therefore supports treating tasting-based distribution as the primary route to market for this category.

The gap between universal detection and sixty percent conversion is nonetheless informative. Every outlet could tell the products apart, but two in five still did not buy, which locates the residual constraint downstream of quality. Plausible barriers include price fit against existing suppliers, the menu development required to use a new ingredient, uncertainty about supply reliability from a small producer, and working capital. These are commercial and operational matters, not product matters, and they are the appropriate focus of subsequent effort.

5. Absorption Capacity of the Channel

The third condition in Figure 1 is absorption, and it is where the evidence turns cautionary. Table 5 and Figure 3 model the bean volume the channel would require under progressive conversion, calibrated on fifteen kilograms of nibs per outlet per month and a winnowing loss of twenty percent, expressed against the regency's unfermented volume of approximately 190 tons per year.

Table 5. Bean absorption by number of converted outlets

Outlets	Nibs (kg/yr)	Beans (kg/yr)	% of 190 t
5	900	1,125	0.6%
10	1,800	2,250	1.2%
15 (current)	2,700	3,375	1.8%
25 (all tested)	4,500	5,625	3.0%

Source: processed data, 2026

DOI: https://doi.org/10.69693/ijmst.v4i2.13879
Lisensi: Creative Commons Attribution 4.0 International (CC BY 4.0)

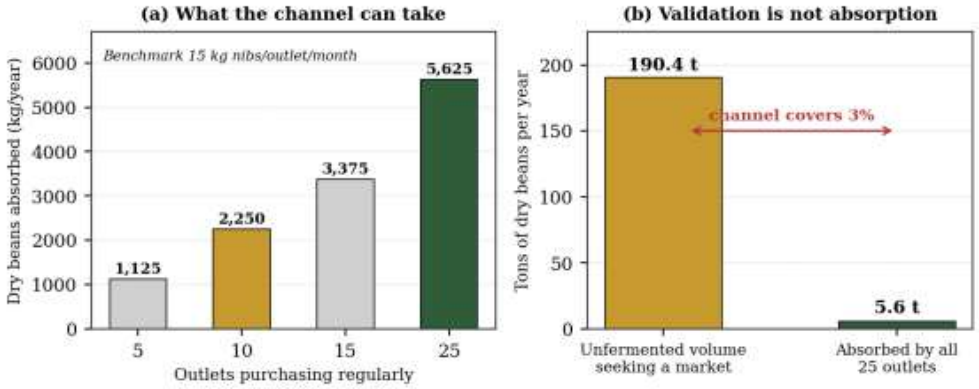

Figure 3. Channel absorption against the volume seeking a market
Source: processed data, 2026

The fifteen outlets already purchasing absorb about 3.4 tons of dry beans per year, some 1.8 percent of the volume sold unfermented in the regency, worth roughly Rp11.8 million in premium annually. Converting every business tested would raise this to about 5.6 tons, or three percent. This is the study's central managerial finding and it qualifies the preceding results rather than contradicting them.

Downstreaming is frequently discussed as though building processing capacity were the binding constraint. The evidence here indicates otherwise. The detectability premise holds unambiguously, so quality is not the obstacle; the obstacle is that the local channel is small relative to the volume a functioning fermentation programme would produce. A village unit sized to local foodservice demand alone would be under-scaled by more than an order of magnitude, and one sized to the supply base would face a demand shortfall. Processing capacity and market access must therefore be planned together, and the sequence matters: securing committed offtake should precede, not follow, the construction of capacity.

The channel nonetheless has strategic value that its volume understates. It supplies proof of concept, reference accounts and a defensible quality claim, all of which are assets in negotiations with the larger buyers who could absorb meaningful volume, including specialty manufacturers, urban craft chocolate producers and export intermediaries. Local outlets are best understood as a validation channel rather than a volume channel.

6. Reading the Result as an Upper Bound

A unanimous outcome invites the objection that the test was undemanding, and the objection deserves a direct answer. Three features of the design widened the contrast as far as it can be widened in practice. The two portions represented the extremes of the post-harvest spectrum, one fully box-fermented and the other dried directly from the wet bean, with no intermediate condition between them. The evaluation format was nibs, which present cocoa flavour with minimal formulation masking, whereas the same beans blended into a sweetened beverage or a baked product would be judged through sugar, dairy and flour. The evaluators taste and purchase ingredients as part of their occupation, so their discriminating ability sits above that of the general public even in the absence of formal sensory training.

Taken together, these features indicate that the detection rate observed here is an upper bound on what fermentation can signal rather than a general estimate of it. Discrimination weakens as the contrast between stimuli narrows (Lawless & Heymann, 2010), and partially fermented lots, which are common where boxes are shared between farmers and turning schedules are irregular, would be expected to yield a lower and more variable rate. Two practical inferences follow. Fermentation must be complete rather than nominal if it is to remain commercially detectable, so quality control at the fermentation stage protects the premium more directly than any effort at downstream presentation. And the finding generalises with a stated boundary, namely that it holds for a fully fermented product presented in a low-masking format, while its extension to composite products in which cocoa is one ingredient among several should be established empirically rather than assumed (Misnawi et al., 2022).

DOI: https://doi.org/10.69693/ijmst.v4i2.13879
Lisensi: Creative Commons Attribution 4.0 International (CC BY 4.0)

7. From Detectability to Willingness to Pay

Detectability and willingness to pay are related but not identical, and the distance between them explains why the premium recorded above remains modest. In the vocabulary of information economics, fermentation quality behaves as an experience attribute at the moment of tasting, since the buyer verifies it directly and requires no assurance from the seller (Nelson, 1970). That property produced complete engagement and a conversion rate of sixty percent. The same property becomes a constraint once the transaction moves beyond arm's length. A buyer purchasing repeatedly from a distance cannot taste every lot before payment, so an attribute that was experiential at the first order becomes a credence attribute at the tenth, and confidence must then rest on documentation rather than on the palate.

This shift accounts for a pattern reported elsewhere in the literature, namely that sensory quality alone rarely captures the full premium it warrants. Willingness to pay for cocoa products responds to origin and award signals that operate independently of sensory cues (Cabrera et al., 2022), and traceability labelling raises purchase intention by lending credibility to the quality claim behind it (Bradu et al., 2014). The operational reading for a village unit is direct. Records of fermentation duration, turning frequency and drying moisture, together with lot identity maintained from the farm to the buyer, are not administrative overhead but the instrument through which a quality that can be tasted once becomes a quality that can be sold repeatedly. Sampling wins the account and documentation retains it, which is to say that the commercial task is to convert a demonstrated product advantage into a position that survives without repeated demonstration (Kotler & Keller, 2016).

8. Channel Structure and the Sequencing of Capacity

The absorption result also carries a structural reading that the arithmetic of Table 5 does not convey on its own. The Indonesian cocoa trade is organised around bulk consolidation, in which beans from many smallholders are aggregated and priced against a general grade rather than an individual lot, so the dominant pricing mechanism carries no means of rewarding a quality it does not measure (Neilson, 2007). Fermentation improves the bean, but the channel that absorbs most of the volume is not built to observe the improvement. The local foodservice channel matters because it reverses this arrangement, since the buyer tastes the specific lot, negotiates directly with the producer and pays for a difference demonstrated in front of them. The limitation is that the reversal holds only at small volume. The channel that can see quality cannot absorb the output, and the channel that can absorb the output does not price the quality, which makes downstreaming at village scale a problem of channel selection as much as one of processing technology.

Combining the three findings yields a sequencing rule more specific than the general injunction to plan capacity and market together. Because detection is not the binding constraint, the operative question is how much capacity is warranted by how much committed offtake at each stage. Table 6 sets out that correspondence on the calibration adopted above, namely fifteen kilograms of nibs per outlet per month and a winnowing loss of twenty percent.

Table 6. Indicative capacity stages against committed offtake

Stage	Committed offtake (kg beans/yr)	Buyer base	Capacity decision
1. Validation	About 1,125	Five local outlets	Existing manual equipment; no new investment
2. Consolidation	About 3,375	Fifteen local outlets (current position)	Add drying and storage capacity; formalise lot records
3. Local saturation	About 5,625	All twenty-five outlets tested	Local ceiling reached; secure an external buyer before further building
4. Expansion	Above 5,625	Specialty manufacturer or export intermediary	Dedicated fermentation unit justified only against a written commitment

Source: processed data, 2026

DOI: https://doi.org/10.69693/ijmst.v4i2.13879
Lisensi: Creative Commons Attribution 4.0 International (CC BY 4.0)

The purpose of the table is not to forecast demand but to make explicit the point at which further capacity ceases to be supported by buyers already in hand. The case examined here sits at the second stage, and the first three stages together remain within three percent of the volume seeking a market, so the decision that determines whether downstreaming succeeds is the transition to the fourth stage. That transition is commercial rather than technical, and it is secured by a written offtake commitment rather than by additional equipment. Programmes that disburse funds against installed capacity targets rather than against contracted demand invert this sequence, and the predictable outcome is an asset that operates below the throughput on which its financing was justified.

4. Conclusion

First, the detectability premise underlying downstreaming holds for cocoa fermentation. All twenty-five food and beverage businesses correctly identified the fermented sample under blind conditions, a result significant at p less than 0.001 with a 95 percent confidence interval of 86.3 to 100 percent, and the pattern is consistent across three segments with different end uses. Second, buyers attributed the difference to a sweeter taste, a stronger aroma and a drier texture, descriptions that independently reproduce the documented biochemistry of fermentation; the first two require tasting to perceive, while the third is available on handling and can serve as a rapid intake check. Third, detection converted into purchase for three outlets in five, a high rate for unsolicited business-to-business acquisition, which locates the residual constraint in price and account management rather than product quality. Fourth, and decisively for policy, the entire tested channel would absorb only about three percent of the volume currently sold unfermented, so detectability is necessary but not sufficient to justify downstreaming investment.

Reference

1. Abubakar, I. (2017). *Jatuh bangun penerapan teknologi fermentasi biji kakao*. Jakarta: IAARD Press.
2. Afoakwa, E. O., Paterson, A., Fowler, M., & Ryan, A. (2008). Flavor formation and character in cocoa and chocolate: A critical review. *Critical Reviews in Food Science and Nutrition, 48*(9), 840–857.
3. Ardhana, M. M., & Fleet, G. H. (2003). The microbial ecology of cocoa bean fermentations in Indonesia. *International Journal of Food Microbiology, 86*(1–2), 87–99.
4. Bradu, C., Orquin, J. L., & Thøgersen, J. (2014). The mediated influence of a traceability label on consumer's willingness to buy the labelled product. *Journal of Business Ethics, 124*(2), 283–295.
5. Cabrera, R. A. R., et al. (2022). Does award and origin labeling influence consumers' willingness-to-pay beyond sensory cues? An experimental auction on improved Philippine tablea. *Food Quality and Preference*.
6. Clopper, C. J., & Pearson, E. S. (1934). The use of confidence or fiducial limits illustrated in the case of the binomial. *Biometrika, 26*(4), 404–413.
7. Deliza, R., & MacFie, H. J. H. (1996). The generation of sensory expectation by external cues and its effect on sensory perception and hedonic ratings: A review. *Journal of Sensory Studies, 11*(2), 103–128.
8. Hasibuan, A. M., & Sayekti, A. L. (2018). Export tax policy in Indonesia: The impacts on competitiveness and price integration of cocoa products. *Pertanika Journal of Social Sciences and Humanities, 26*(1), 535–552.
9. Kotler, P., & Keller, K. L. (2016). *Marketing management* (15th ed.). Harlow: Pearson Education.
10. Lawless, H. T., & Heymann, H. (2010). *Sensory evaluation of food: Principles and practices* (2nd ed.). New York: Springer.
11. Misnawi, et al. (2022). Cocoa and chocolate products: The sensory characteristics that affect consumers' acceptance. *Pelita Perkebunan*.
12. Neilson, J. (2007). Global markets, farmers and the state: Sustaining profits in the Indonesian cocoa sector. *Bulletin of Indonesian Economic Studies, 43*(2), 227–250.
13. Nelson, P. (1970). Information and consumer behavior. *Journal of Political Economy, 78*(2), 311–329.
14. Ramadhan, A., et al. (2021). Sensory profiles of chocolate drinks made from commercial fermented cocoa powder and unfermented cocoa beans. *Current Research in Nutrition and Food Science, 9*(3).
15. Rohan, T. A. (1964). The precursors of chocolate aroma: A comparative study of fermented and unfermented cocoa beans. *Journal of Food Science, 29*(4), 456–459.
16. Wollgast, J., & Anklam, E. (2000). Review on polyphenols in Theobroma cacao: Changes in composition during the manufacture of chocolate and methodology for identification and quantification. *Food Research International, 33*(6), 423–447.

DOI: https://doi.org/10.69693/ijmst.v4i2.13879
Lisensi: Creative Commons Attribution 4.0 International (CC BY 4.0)