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DEVELOPMENT AND ACCEPTABILITY OF CALAMANSI-GINGER CONCENTRATE

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ABSTRACT This study aimed to develop and assess the acceptability of a calamansi-ginger concentrate, combining the nutritional benefits of calamansi (Citrus microcarpa) and ginger (Zingiber officinale) to create a health-focused beverage. The concentrate was prepared with varying concentrations of ginger extract—5%, 10%, and 15%—along with basic condiments like sugar, water, and salt. A sensory evaluation was conducted with 50 respondents using a 9-point hedonic scale, measuring taste, aroma, aftertaste, color, and general acceptability. Results indicated that the 15% ginger extract formulation was most favored in terms of taste, aftertaste, and overall acceptability, while the 5% ginger extract had the lowest scores. The findings suggest that the higher ginger concentration provided a more pronounced and pleasant flavor, enhancing the overall consumer experience. Although aroma and color were not significant factors, the study highlighted the importance of ginger intensity in shaping consumer preferences. The findings offer valuable insights for product development, emphasizing the 15% ginger extract formulation for broader market appeal and potential health benefits.

Keywords: acceptability , natural juice, nutritional drinks, plant extracts, processing value adding,

INTRODUCTION

Rationale

Citrus madurinces, often known as calamansi or the Philippine Lemon, is a fruit that is native to the Philippines and is one of the main exports of that nation. The plant produces white or purple flowers and has wing-like appendages on the leaf stalks. The fruit is segmented into parts and has a delicious pulp with a spongy or leathery rind (Department of Agriculture-Philippine Rural Development Program, n.d.). Of all the citrus species, it is the one that is grown in backyards the most. It can survive in a range of different environmental settings. It grows to a height of between 2 and 7 12 meters when fully grown. Its large, egg-shaped leaves have a dark green upper surface and a light green underside. The fruit is circular, between 2 to 40.5 cm in diameter, and has a greenish-yellow tint (Department of Agriculture, n.d.).

The calamansi, like its relatives the mandarin, pomelo, and sweet orange, is a fruit high in calcium, iron, phosphorus, and Vitamin C, also known as ascorbic acid. It is the most widely consumed and used citrus fruit in the nation. Its juice is nourishing and is typically put into a fruit beverage that aids in the prevention of respiratory illnesses. Additionally, it promotes bone health and growth, especially in growing children. It can be added to a variety of food dishes, such as fish steak, or used as a flavoring agent in sweets like leche flan. Its pulp is a key component of many purees, concentrates, syrups, and drinks. The

peel is made into jams, candies, and marmalade. With its alkalinizing effect, on the body calamansi helps circulate blood evenly and facilitates normal digestion (www.da.gov.ph, 2016).

Ginger rhizome, scientifically known as Zingiber officinale, is a versatile plant recognized for its significant contributions to culinary practices and various medicinal applications. The utilization of ginger rhizome can be delineated into several key areas: nutritional benefits, antioxidant properties, medicinal uses, and applications in food preservation.

Ginger rhizome is widely celebrated for its rich array of bioactive compounds, primarily gingerols and shogaols, which contribute notably to its antioxidant capabilities. Studies have demonstrated that ginger possesses high levels of flavonoids and phenolic compounds, enhancing its antioxidant potential (Min et al., 2017; , Alam et al., 2020). The antioxidant activities of ginger rhizomes have been linked to their ability to neutralize free radicals, thus helping mitigate oxidative stress and inflammation in the body (Ghasemzadeh et al., 2010; , Dugasani et al., 2010). These properties make ginger an appealing choice for functional foods aimed at promoting health and wellness.

Concentrated fruit juice is the product that complies with the standard, except water has been physically removed in an amount sufficient to increase the Brix level to a value at least 50% greater than the Brix value established for reconstituted juice from the same fruit, as indicated. In the production of juice that is to be concentrated, suitable processes are used and may be combined with simultaneous diffusion of the pulp cells or fruit pulp by water provided that the water-extracted soluble fruit solids are added in-line to the primary juice, before the concentration procedure.

Calamansi (Citrus microcarpa) is known for its high vitamin C content and potential effects on glycemic control, making it a favorable base for health drinks (Siner et al., 2020). Its tart flavor enhances the sensory profile of the drink when combined with ginger extract. When selecting the proportions, a typical recommendation for balance between flavor and health benefits is maintaining ginger extract between 10% to 15% per kilo of calamansi juice (Ningsih et al., 2022).

Inspite of their nutritional potentials, there is a limited exploration of a nutritional concentrate made from calamansi juice and ginger extract, combined with basic condiments like sugar, water, and salt. While both calamansi and ginger are known for their individual health benefits, such as vitamin C and anti-inflammatory properties, there is a lack of studies examining their combined use in a concentrated form. The formulation process, including the correct proportions and methods for extracting these ingredients to create a shelf-stable and nutritious product, remains under-researched. Additionally, the nutritional value of this concentrate, including the preservation of nutrients and the impact of added ingredients like sugar and salt, has not been sufficiently explored. Consumer acceptability is another crucial area, as the unique flavor profile of the product may pose challenges in terms of taste, texture, and overall appeal. Furthermore, there is a gap in understanding the market potential and cultural relevance of such a product, particularly in regions where calamansi and ginger are locally sourced. Research in these areas could help determine the feasibility of developing a sustainable, health-focused beverage that combines traditional ingredients with modern consumer preferences.

OBJECTIVES

This study was conducted to:
1.To develop calamansi-ginger concentrate.
2.To determine the acceptability of calamansi-ginger concentrate in terms of taste, aroma, aftertaste, color, and general acceptability.

METHODOLOGY

Research Design

The study utilized an experimental research design laid out in a Complete Randomized Design with four (4) treatments including the control and replicated three (3) times with a total of 12 variates to be tested for acceptability level. Treatment 1 was 5% ginger extract per kilo of calamansi juice, treatment was 10% ginger extract per kilo of calamansi juice, and treatment 3 was 15% ginger extract per kilo of calamansi juice, while the control was pure calamansi juice. The experimental lay out was shown in figure 1 below.

Selection of Calamansi Fruit

The calamansi fruit used was matured with dark green skin color. The fruit was harvested by hand or by clipping with shears. Calamansi was collected in the locality of Guimaras.

Selection of Ginger

The ginger used was matured, aging 9-10 months. Matured ginger has a stronger flavor than immature. The ginger can either be bought in the market or directly from the ginger farmers available in the locality.

Extraction of Calamansi Juice

To extract the calamansi juice, first, the calamansi fruits were thoroughly washed with tap water. The washed fruits were then sanitized using a brine solution consisting of 15% salt per liter of water and soaked for 30 minutes. After sanitization, the fruits were sliced while still submerged in the brine solution. The slices were squeezed to extract the juice, which was then strained to remove any pulp. The strained juice was set aside and covered to prevent contamination.

Extraction of Ginger Juice

Similarly, for the ginger juice extraction, the ginger was peeled and washed, then sliced into pieces. A small amount of the sliced ginger was placed in a juice extractor at a time to extract the juice. The extracted juice was collected in a clean bowl, strained to remove any particles, and covered to avoid contamination.

Procedures in making Calamansi-Ginger Concentrate

To make the calamansi-ginger concentrate, the strained calamansi juice and ginger juice were mixed together. Separately, water, sugar, and salt were combined and stirred thoroughly until the sugar dissolved completely. The mixture of water, sugar, and salt was then strained to remove any unwanted particles. Next, the two mixtures—calamansi-ginger juice and the water-sugar-salt mixture—were combined in a casserole and stirred well. The combined mixture was then cooked over high heat until it reached a boil. The heat was reduced to medium, and the mixture was stirred occasionally to prevent burning. It was cooked for 45 minutes, after which it was allowed to cool to about 40°C before being transferred into a plastic bottle. The concentrate was now ready to serve and could be stored at room temperature or refrigerated to extend its shelf life for up to six months.

Acceptability Test

The acceptability test was done using the public acceptability of 50 respondents to taste the developed product. A 9-point hedonic scale was used ranging from dislike extremely (1) to like extremely (9).

Data Analysis

The data were analyzed using mean and One-Way Analysis of Variance (ANOVA) for CRD. The mean was further analyzed using the Multiple Range Test to determine the most significant.

RESULTS AND DISCUSSIONS

Acceptability

The table below shows the acceptability of calamansi-ginger concentrate in terms of taste, aroma, aftertaste, color, and general acceptability.

Column 2 presents the acceptability level of the calamansi-ginger concentrate based on taste, revealing that the addition of ginger extract significantly influences consumer preference. The concentrate with 15% ginger extract achieved the highest mean acceptability score of 9.00, followed by 10% ginger extract with a score of 8.33, no supplementation at 7.67, and 5% ginger extract with the lowest score of 7.00. The results indicate that a higher percentage of ginger extract enhances the taste appeal of the concentrate, with the 15% supplementation being the most favored. This suggests that the optimal balance between calamansi and ginger is achieved with a 15% ginger concentration, as it likely provides a better flavor profile, offering a more distinct and pleasant taste that consumers find acceptable. On the other hand, the 5% supplementation was the least accepted, which could imply that the ginger flavor was not pronounced enough to complement the sourness of the calamansi, thus diminishing the overall taste appeal.
The findings have significant implications for product development and marketing. The 15% ginger extract formulation can be promoted as the most preferred variant, ensuring higher consumer satisfaction and potentially greater market success. Meanwhile, the 5% ginger extract formulation, which received the lowest acceptability score, may need reformulation to either increase the ginger concentration or adjust the ingredient balance to improve its taste. This study emphasizes the importance of flavor balance in developing consumer-

friendly health products, suggesting that a careful optimization of ingredient proportions is crucial to maximize both nutritional value and taste acceptability.
Given the current findings, producers may consider incorporating a ginger extract concentration of 15% in their calamansi juice formulations, as this level may offer enhanced flavor and potential health benefits based on preliminary evaluations. Additionally, marketing such beverages as functional drinks may resonate with health-conscious consumers looking for flavorful options (Mg et al., 2018).

Aroma

Column 3 presents the acceptability level of the calamansi-ginger concentrate based on aroma. Interestingly, the mean acceptability scores were not significantly different across the different levels of ginger extract supplementation. The concentrate with 15% ginger extract had a slightly higher mean score of 7.67, compared to the control (no ginger supplementation), which also scored 7.67, followed by 5% ginger extract and 10% ginger extract, both with a mean score of 7.33. These results indicate that the aroma of the concentrate was generally well-received across all variations, with no clear preference for any particular ginger extract supplementation.

The lack of significant differences in aroma acceptability suggests that the ginger extract's aroma did not notably influence the overall sensory experience for consumers. The slight variation in scores indicates that the ginger aroma, at varying concentrations, did not overpower the calamansi scent or alter the product's aroma enough to make a noticeable impact.

From a product development perspective, this finding implies that aroma may not be a critical factor in determining the overall appeal of the concentrate. Therefore, the formulation can focus more on balancing the taste and nutritional aspects, without much concern for the slight variations in aroma that were observed. This could allow manufacturers to focus on optimizing the ginger concentration for taste, without having to significantly adjust the aroma, as it was not a major determinant of consumer.

Functional drinks featuring ginger and calamansi have been recognized for their positive associations with freshness, spiciness, and overall flavor balance, thus appealing to health-conscious consumers (Olaniran & Abiose, 2019).But not in the aaroma.

Aftertaste

Column 4 of Table 2 presents the acceptability of the calamansi-ginger concentrate in terms of aftertaste. The results show that the concentrate with 15% ginger extract received the highest mean score of 8.67, followed by 10% ginger extract at 8.33, and both the 5% ginger extract and the control (no ginger supplementation) at 7.33. These findings indicate that the 15% ginger extract formulation was the most accepted in terms of aftertaste, while the 5% ginger extract and control were the least preferred.

The 15% ginger extract formulation's higher aftertaste acceptability suggests that the ginger flavor provided a satisfying lingering taste, enhancing the overall sensory experience. The noticeable drop in acceptability for the 5% ginger extract and control may imply that the ginger flavor was too mild in the lower concentrations, leaving a less favorable

aftertaste that consumers found less enjoyable. This finding highlights the importance of ginger intensity in creating a pleasant aftertaste that contributes positively to the overall flavor profile.

From a product development standpoint, these results suggest that the 15% ginger extract concentration should be prioritized to ensure the best consumer experience, particularly in terms of aftertaste. The 5% ginger extract and control formulations, which received the lowest aftertaste scores, may need further refinement in terms of increasing the ginger concentration or adjusting the ingredient balance to improve the aftertaste. This underscores the significance of ginger extract supplementation not only for flavor but also for creating a long-lasting, favorable aftertaste that can differentiate the product in the market.

The aftertaste of ginger in a formulation can be described as warm and savory, which is a key selling point for ginger beverages. The moderate intensity of the ginger flavor at 15% tends to linger pleasantly after consumption, enhancing the drinking experience. Research suggests that participants rate the aftertaste of ginger-containing drinks favorably compared to lower concentrations or control beverages lacking ginger (Hamdoon et al., 2009).

Acceptability of the Color

Column 5 presents the acceptability of the calamansi-ginger concentrate in terms of color. The results indicate that there were no significant differences in the mean acceptability scores across the different ginger extract concentrations. However, the 15% ginger extract formulation had a slightly higher mean score of 8.00, followed by 10% ginger extract at 7.67, and both 5% ginger extract and the control (no ginger supplementation) at 7.33. Despite these variations, all formulations showed relatively similar levels of acceptability with respect to color.

These findings suggest that color was not a critical factor in determining the overall consumer preference for the concentrate, as all formulations received similar scores. The slight difference in the mean acceptability of 15% ginger extract indicates that it may have contributed to a slightly more appealing or distinctive color, but the variation was not enough to cause a significant preference or aversion among consumers.

From a product development perspective, this implies that color is not a key determinant of consumer acceptability in this product. Therefore, manufacturers may focus more on optimizing the taste, aftertaste, and aroma of the concentrate, rather than investing significant resources in adjusting the color. The consistency in acceptability across the different formulations indicates that the product's visual appeal is not a major barrier to market success, and the concentrate can be marketed based on its health benefits and flavor profile, rather than its appearance.

Research shows that consumers often associate brighter, vibrant colors with freshness and health benefits, which can enhance the overall acceptability of food and beverage products. A study highlighted that color evaluation is integral to consumer satisfaction, with shades indicative of fruit flavors often positively impacting perceived quality (Akullo et al., 2023), Adeoti et al., 2021). Furthermore, the visual appearance of a drink can

significantly influence consumers' initial impressions and willingness to try the product.

General Acceptability

Column 6 of Table 1 presents the general acceptability of the different preparations of calamansi-ginger concentrate, indicating that the 15% ginger extract supplementation was the most accepted, with a mean score of 9.00. This was followed by the 10% ginger extract at 8.00, the control (no ginger supplementation) at 7.67, and the 5% ginger extract at the lowest mean score of 7.00. The 15% ginger extract formulation was clearly the most favored, while the 5% ginger extract received the lowest level of acceptability.

These results imply that higher ginger concentrations in the concentrate contributed significantly to its overall appeal, especially in terms of taste, aftertaste, and overall sensory experience. The 15% ginger extract formulation likely struck the best balance, offering a more pronounced and satisfying flavor profile that consumers preferred. Conversely, the 5% ginger extract formulation was the least accepted, suggesting that a lower concentration of ginger may not have provided a strong enough flavor impact, leading to lower consumer satisfaction.

From a product development standpoint, these findings emphasize that the 15% ginger extract formulation should be prioritized for future production, as it achieved the highest general acceptability. Manufacturers should consider the 5% ginger extract formulation for reformulation, potentially increasing the ginger concentration or adjusting other ingredients to improve its overall appeal. The results highlight the importance of ingredient concentration in shaping consumer preferences, particularly for flavor-driven products like the calamansi-ginger concentrate. This could guide future marketing strategies, focusing on the 15% ginger extract variant as the flagship product for the brand.

Research findings show that the general acceptability of ginger-calamansi concentrates correlates with individual preferences and health consciousness. Given the increasing trends in healthy beverage consumption, the potential anti-inflammatory and antioxidant properties of ginger further enhance the product's attractiveness (Al-Amin et al., 2006). Therefore, the 15% ginger extract formulation not only satisfies sensory requirements but also aligns with consumer demands for functional benefits.

Table 1. Acceptability of calamansi-ginger concentrate in terms of taste, aroma, aftertaste, color, and general acceptability.

Treatment	Taste	Aroma	Aftertaste	Color	General Acceptability
A (5%)	7.00c	7.33	7.33b	7.33	7.00b
B (10%)	8.33ab	7.33	8.33ab	7.67	8.00ab
C (15%)	9.00a	8.33	8.67a	8.00	9.00a
D (Control)	7.67bc	7.67	7.33b	7.33	7.67b
f-test	*	ns	*	ns	*
cv%	8.1%	7.5%	7.3%	9.3%	7.3%

CONCLUSIONS AND RECOMMENDATIONS

The development of the calamansi-ginger concentrate yielded valuable insights into both its nutritional benefits and consumer acceptability. The study demonstrated that the 15% ginger extract formulation was the most favored across various sensory attributes such as taste, aftertaste, and general acceptability, making it the optimal concentration for future production. The 5% ginger extract formulation, on the other hand, received the least acceptance, highlighting the importance of ginger's intensity in enhancing flavor and overall appeal. While aroma and color were not significant factors in determining acceptability, the aftertaste emerged as a crucial component in creating a satisfying consumer experience. The findings underscore the potential of this concentrate as a health-focused beverage with functional benefits, catering to the growing demand for flavorful yet nutritious drinks.

Future product development should prioritize the 15% ginger extract formulation, as it was the most favored in terms of taste and aftertaste, making it the optimal choice for consumer satisfaction. The 5% ginger extract formulation, which received the least acceptance, should be reconsidered by either increasing the ginger concentration or adjusting the ingredient balance to enhance its flavor and aftertaste. In marketing the product, emphasis should be placed on its health benefits, highlighting the antioxidant and anti-inflammatory properties of ginger alongside the vitamin C content of calamansi, positioning it as a functional beverage appealing to health-conscious consumers. Additionally, given that aroma and color were not significant factors in the overall acceptability, further exploration of product variations, such as adjusting sugar content or experimenting with other natural flavorings, could help cater to diverse consumer preferences without compromising the product's core nutritional benefits. Finally, the six-month shelf life at room temperature offers a promising opportunity for broader market distribution, particularly in regions where calamansi and ginger are locally sourced, making the product both affordable and sustainable for wider consumption.

References

Adeoti, O. A., Alabi, A. O., & Elutilo, O. O. (2021). Physicochemical, anti-oxidant and sensory characteristics of spiced jam from blends of selected tropical fruits. Asian Food Science Journal, 28-40. https://doi.org/10.9734/afsj/2021/v20i1230389

Akullo, J. O., Kiage-Mokua, B., Nakimbugwe, D., Ng'ang'a, J., & Kinyuru, J. (2023). Color, ph, microbiological, and sensory quality of crickets (gryllus bimaculatus) flour preserved with ginger and garlic extracts. Food Science & Nutrition, 11(6), 2838-2851. https://doi.org/10.1002/fsn3.3262

Alam, M. A., Saleh, M. S. M., Mohsin, G. M., Nadirah, T. A., Aslani, F., Rahman, M. M., …& Alam, M. Z. (2020). Evaluation of phenolics, capsaicinoids, antioxidant properties, and major macro-micro minerals of some hot and sweet peppers and ginger land-races of malaysia. Journal of Food Processing and Preservation, 44(6). https://doi.org/10.1111/jfpp.14483

Al-Amin, Z., Thomson, M., Al-Qattan, K. K., Peltonen-Shalaby, R., & Ali, M. (2006). Anti-diabetic and hypolipidaemic properties of ginger (zingiber officinale) instreptozotocin-induced diabetic rats. British Journal of Nutrition, 96(4), 660-666. https://doi.org/10.1079/bjn20061849

Anandaraj, M., Devasahayam, S., Zachariah, T.J., Eapen, S.J., Sasikumar, B., and Thankamani, C.K. 2001. Ginger (Extension Pamphlet). J. Rema and M.S. Madan, Editors. Indian Institute of Spices Research, Calicut, Kerala, India.

Baliga, M. S., Jagetia, G. C., Rao, S. K., and Babu, K. (2013). Evaluation of nitric oxide scavenging activity of certain spices in vitro: a preliminary study. Nahrung 47: 261-264.

Bussien, H. (2018). Beverage trends. The world of ingredients Journal 4: 10–13

Dugasani, S., Pichika, M. R., Nadarajah, V. D., Balijepalli, M. K., Tandra, S., & Korlakunta, J. N. (2010). Comparative antioxidant and anti-inflammatory effects of [6]-gingerol, [8]-gingerol, [10]-gingerol and [6]-shogaol. Journal of Ethnopharmacology, 127(2), 515-520. https://doi.org/10.1016/j.jep.2009.10.004

Egan, H., Kirk, R. S. and Sawyer, R. (2017). Pearsons chemical analysis of food 8th ed. Essex, England: Longman Scientific and Technical

Fabio, A., Corona, A., Forte, E., and Quaglio, P. (2013) Inhibitory activity of spices and essential oils on psychrotrophic bacteria. New Microbiol. 26:115-20.

Ghasemzadeh, A., Jaafar, H. Z. E., & Rahmat, A. (2010). Antioxidant activities, total phenolics and flavonoids content in two varieties of malaysia young ginger (zingiber officinale roscoe). Molecules, 15(6), 4324-4333. https://doi.org/10.3390/molecules15064324

Hamdoon, A. A., Kalo, M. S., Khashab, E. M. A., & Katib, S. M. A. (2009). The antioxidant effects of flavonoids and non flavonoid part extracted from ginger (zingiber officinale) roots.. Rafidain Journal of Science, 20(6), 18-31. https://doi.org/10.33899/rjs.2009.39940

Jagetia, G., Baliga, M., and Venkatesh, P. (2014). Ginger (Zingiber officinale Rosc.), a dietary supplement, protects mice against radiation-induced lethality: mechanism of action. Cancer Biother Radiopharm. 19: 422-435.

Mg, A., MAE, G., EHE, A., & Sm, D. (2018). Application of some insensitive probiotic lactic acid bacteria and ginger as functional dairy products. Microbial Biosystems, 3(1), 60-73. https://doi.org/10.21608/mb.2018.12360

Min, B., Marsh, L., Brathwaite, K., & Daramola, A. O. (2017). Effects of tissue culture and mycorrhiza applications in organic farming on concentrations of phytochemicals and antioxidant capacities in ginger (zingiber officinale roscoe) rhizomes and leaves. Journal of Food Science, 82(4), 873-881. https://doi.org/10.1111/1750-3841.13661

Mun Wai Cheong, et. al, 2012, Characterization of calamansi (Citrus microcarpa). Part I: Volatiles, aromatic profiles and phenolic acids in the peel, Food Chemistry, Volume 134, Issue 2, 2012,Pages 686-695, ISSN 0308-8146, https://doi.org/10.1016/j.foodchem.2012.02.162.

Natta, L., Orapin, K., Krittika, N., and Pantip, B. (2018). Essential oil from five Zingiberaceae for anti food-borne bacteria. Int Food Res J. 15: 337-346.

Ningsih, O. S., Widyawati, F., Nggarang, B. N., Jehoman, A. S. D., Nasvia, D., & Tono, K. F. (2022). Preventive and promotional effort for type 2 diabetes mellitus based on local resources. ABDIMAS: Jurnal Pengabdian Masyarakat, 4(2), 1074-1080. https://doi.org/10.35568/abdimas.v4i2.1343

Sasidharan, I.A., and Menon, N. (2010). Comparative chemical composition and antimicrobial activity fresh & dry Ginger oils (Zingiber officinale Roscoe). Int J Curr Pharma Res. 2: 39-43.

Siner, A., Sevanesan, M. S. A. P., Ambomai, T., Wahab, Z. A., & Lasem, L. (2020). Blood glucose response to a calamansi drink in healthy adults: a non-randomised study. BMC Research Notes, 13(1). https://doi.org/10.1186/s13104-020-05250-8

Travers, S. (2013). Dry matter and fruit quality: Manipulation in the field and evaluation with NIR spectroscopy. Ph.D. Thesis. Department of Food Science, AU Aarslev. Retrieved from http://pure.au.dk/portal/files/56894564/Dry_matter_and_fruit_quality_manipulation_in_the_field_and_evaluation_Sylvia_Travers_Thesis_August_2013_compressed_opt.pdf

Olaniran, A. F. and Abiose, S. H. (2019). Nutritional evaluation of enhanced unsieved ogi paste with garlic and ginger. Preventive Nutrition and Food Science, 24(3), 348-356. https://doi.org/10.3746/pnf.2019.24.3.348