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TEBBEG AND YACON AS A NOVEL SUBSTRATE FOR WINE FERMENTATION

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Abstract
The study focused on the development and evaluation of wine produced from Tebbeg and Yacon juice using different juice-to-water ratios (T1 – 1:2, T2 – 1:1.5, T3 – 1:1, T4 – 1:0.5). The wine samples were assessed for physicochemical properties, microbial and sensory quality. Microbial analysis revealed the absence of *Escherichia coli* and molds in all formulations, indicating microbiological safety. Physicochemical analysis showed that the ratio of one part tebbeg and 1 part yacon juices exhibited the most efficient fermentation, with the lowest Brix value (9^0) and the highest alcohol content (8.5%). In contrast, other formulations displayed less sugar utilization and lower ethanol levels. Sensory evaluation indicated that 1:1 consistently received the highest scores for taste intensity, sweetness, body, texture, tannin, aftertaste, and aroma, suggesting superior overall acceptability. The results demonstrate that Tebbeg and Yacon juice can be successfully fermented into a functional and safe wine, with a 1:1 juice-to-water ratio providing the optimal balance of sensory and physicochemical quality. This study highlights the potential of underutilized crops such as Tebbeg and Yacon for developing innovative fermented beverages with both nutritional and functional benefits.

KEYWORDS: Tebbeg, yacon, physiochemical, sensory, and microbial analysis

INTRODUCTION

The increasing interest in functional and innovative fermented beverages has encouraged the exploration of non-traditional raw materials for wine production. While grapes remain the primary substrate for conventional wines, the utilization of underexploited fruits and roots offers significant potential for developing nutritionally enriched and value-added products. Among these, Tebbeg (*Ficus nota)* and yacon (*Smallanthus sonchifolius*) have gained attention due to their unique compositional and functional properties.

Yacon (*Smallanthus sonchifolius*), a perennial herbaceous plant belonging to the *Asteraceae* family, originates from the Andean region of South America. The term yacon derives from the Quechua word *yakku*, meaning tasteless or flavorless Lachman, 2003. This plant is distinguished by its aerial stems, reaching 1–3 m in height. It is primarily cultivated for its tuberous roots, which are appreciated for their sweet taste and crunchy texture, resembling an apple or watermelon Grau et al. 1997; Ojansivua et al. 2011). It is also widely recognized for its prebiotic properties, low glycemic index, and high antioxidant potential, making it an attractive ingredient for functional food and beverage formulations.

The fig fruit known as Tibig in Tagalog and tebbeg in Ilokano is a popular tree in the Philippines. Tibig ripe fruits are edible for human consumption. This fruit contributes unique phytochemical compounds, sugars, and indigenous microflora that may influence fermentation dynamics and final product quality. It is a tropical fruit rich in dietary fiber, vitamins, and bioactive compounds such as phenolics and flavonoids. These constituents contribute to its antioxidant capacity and potential health benefits, making it a promising candidate for fermentation-based products. Its natural sugar content also supports microbial activity during fermentation, which is essential for alcohol production. It can also be made into fruit juices with the addition of sugar or honey to make it more delicious (Zacsarian, 2020)

Wine fermentation is a complex biochemical process primarily driven by yeast and influenced by a range of microbial populations, including lactic acid bacteria. These microorganisms play a critical role in sugar conversion, flavor development, and overall product stability. Understanding microbial dynamics during fermentation is essential to ensure product safety, optimize fermentation efficiency, and achieve consistent quality.

The growing demand for novel fermented beverages with enhanced nutritional and functional properties has stimulated research into the use of alternative plant substrates in wine production. Traditional winemaking primarily relies on grapes; however, the exploration of underutilized crops offers opportunities to diversify products, improve nutritional value, and promote sustainable use of local resources. In this context, *Tebbég* (local/traditional plant source) and yacon (*Smallanthus sonchifolius*), a tuberous root known for its high fructooligosaccharide (FOS) content, present

promising raw materials for innovative wine development. The combination of these two substrates may result in a distinctive fermented beverage with desirable sensory and health-related attributes.
Despite the recognized potential of yacon and locally available plant resources like Tebbég, limited studies have investigated their combined use in wine production. Therefore, this study aims to develop wine from *Tebbég* and yacon juice and to evaluate its quality through microbial analysis, physicochemical characterization, and sensory assessment. The findings are expected to contribute to the development of innovative functional beverages and promote the utilization of underexploited agricultural resources.

REVIEW OF RELATED LITERATURE

Yacon is an underutilized fruit crop in small-scale farming, but it has great potential to become a profitable product through organic cultivation. In Nepal, Yacon is being commercially produced in various parts of the country, but is still not being efficiently utilized in the market. Yacon itself is an abundant source of fructooligosaccharide (FOS). FOS is a type of sugar that has a lower calorie value than other sugar types, and its intake favors the growth of health-promoting bacteria while reducing the pathogenic bacteria populations. The research work on the production of yacon wine has been carried out by using yacon juice only, and works regarding the possibility of preparing wines from yacon pulp and yacon syrup are scarce. Moreover, studies related to the preparation and quality analysis of herbal wines in the Nepalese context have not been carried out. Information on the antioxidant activity of these wines is also scanty.
The roots of yacon are categorized by weight, and their water content varies by location, affecting the sugar and protein levels within [Campos et al 2012; Popenoe, 1989]. Yacon's sugar profile is significantly influenced by environmental factors and post-harvest storage, with its roots containing a high percentage of linear fructooligosaccharides (FOS) and inulin-type substances [Gibson, 1995; Delgado, 2013]. Unlike many Andean roots, yacon does not store starch but instead follows a C3 photosynthesis pathway, similar to the common potato [Pedroza, nd; Banse, 1983]. The nutritional and functional benefits of yacon are further highlighted by its high content of bioactive compounds, including essential amino acids, polyphenolic compounds, and phytoalexins, contributing to its categorization as a functional food with significant prebiotic properties [Bonet, 2010; Takenaka, 2003; Inoue, 1995]

Sensory Evaluation

The quality of a food product, including wine, determines its ultimate acceptance by the consumer. Quality is directly related to consumer acceptance, which is difficult to quantify. Thus, it is important to understand what quality means. Quality is a composite of those characteristics that differentiate individual units of a product, which have significance in determining the degree of acceptability of that unit by the consumer. Sensory analysis is one of the most important methods in food quality evaluation. Determining the quality of a product is incomplete without a sensory evaluation, as other methods, such as physical, chemical, and microbiological methods, fail in product development if a sensory evaluation is not carried out (Joshi et al. 2021).
The quality of wine is reflected in the balance, intensity, complexity, aftertaste, and aroma, among which aroma is a significant parameter for evaluating the wines. This determines the differences in wines around the world, thereby affecting consumer preferences (Jiang & Zhang, 2018).
Nowadays, it is becoming equally clear that moderate wine consumption (250– 300 ml/day) has undeniable health benefits. Multiple epidemiological studies suggest that daily, moderate alcohol consumption, and especially wine, is associated with a reduction in all-cause mortality. This is expressed in a U-shaped curve, with increased mortality being associated with both excess alcohol intake and abstinence. This is particularly evident in the reduced incidence of cardiovascular disease in moderate alcohol consumers. In addition, it reduces the likelihood of non-insulin-dependent diabetes, combats hypertension, and reduces the frequency of certain cancers and several other diseases.
Physicochemical parameters such as pH, titratable acidity, total soluble solids, and alcohol content are important indicators of fermentation progress and product quality. These factors influence not only the stability and shelf life of the wine but also its sensory attributes. Sensory evaluation, corresponding to color, aroma, taste, and overall acceptability, is equally important in determining consumer preference and market viability.

Objectives of the Study

This study determines the Physico-Chemical and Sensorial Characterization of Tebbeg-Yacon Wine, particularly in the use of different water ratios in the formulations. Specifically, it tried to determine:

1. The microbial analysis of the formulated tebbeg-yacon wine;
2. The sensory evaluation of tebbeg-yacon wine after fermentation in terms of:

A. Visual Observation
- a.1. Clarity
- a.2. Color

B. Olfactory Observation
- b.1. Intensity of Smell

b.2. Type of Smell

C. Tasting Observation

c.1. Intensity of taste

c.2. Acidity

c.3. Sweetness

c.4. Body

c.5. Texture

c.6. Tannin

c.7. Aftertaste

3. The significant difference of the tebbeg-yacon wine formulations;
4. The physico-chemical analysis of the best tebbeg-yacon wine formulation: Alcohol and sugar content after fermentation.

METHODOLOGY

Research Design and Treatments

The research method employed in this study was the experimental method with Completely Randomized Design. The quality of the tebbeg-yacon wine was determined through microbial analysis, sensory evaluation, and sugar and alcohol content determination.

T1- tebbeg & yacon Juice & water (1:2)

T2 - (tebbeg & yacon juice + water (1:1.5)

T3 – (tebbeg & yacon juice + water (1:1)

T4 – (tebbeg and Yacon juice + water (1:0.5)

Population and Sampling

To assess the consumer acceptability of the final products, thirty male and female drinkers who claimed to be physically fit acted as taste panelists and were selected using purposive sampling to evaluate the produced wines.

Data Gathering Instrument

The sensory evaluation sheet consists of three parts, namely: visual observation, olfactory observation, and tasting observation. On the visual observation, this comprised two criteria: clarity and color. Olfactory observations also included the intensity of smell and type of smell. Lastly, the tasting observation has seven criteria as follows: intensity of taste, acidity, sweetness, body, texture, tannin, and aftertaste. The 9-point Hedonic Scale was also used to evaluate the sensory characteristics of Tebbeg- yacon wine.

As regards the level of perception of the finished products, the mean was used. and further treated with Analysis of Variance (ANOVA) to determine if there is a significant difference between and among treatment means, and further analyzed using Tukey-Kramer Test, if the result was found significant.

Data Gathering Procedure

Sensory Evaluation of the Tebbeg-Yacon Wine Formulations

The physical properties of wines in terms of visual, olfactory, and tasting observations were determined through organoleptic testing on the consumer acceptability of wine. The taste panelists were asked to rate the coded wine samples using a prepared scorecard with a 9-Point Hedonic Scale. This was served in clean, transparent wine glasses, which were randomly labeled.

Physico-chemical Analyses of Tebbeg-Yacon Wine (Sugar, Alcohol, and Microbial Analyses)

Initial data on ^{0}Brix and potential alcohol were recorded using the hand refractometer. The refractometer was used to measure the percent soluble solids of sugars, and referred to as ^{0}Brix (^{0}Bx) concentration of sugars expressed in terms of number of grains of sucrose per 100 grams of liquid.

The alcohol content and microbial determinations of the wine samples were transported to the Molecular Microbiology and Biotechnology Laboratory, Mariano Marcos State University, Batac, Ilocos Norte. The physicochemical parameters were taken during and after the fermentation period. This was the basis for the computation of alcohol content (%) present in the pomegranate wine formulations.

Statistical Treatment of Data

The data gathered were treated with mean, standard deviation, and Analysis of Variance (ANOVA). Further analysis was computed using the Tukey-Kramer Test if the data was found significant.

Data Categorization

A 9-Point Hedonic Scale was used to evaluate the finished products. The scale is shown below:

Numerical Rating	Statistical Limits	Descriptive Rating
9	8.13 – 9.00	Like Extremely
8	7.24 – 8.12	Like Very Much
7	6.35 – 7.23	Like Moderately
6	5.46 – 6.34	Like Slightly
5	4.57 – 5.45	Neither Like nor Dislike
4	3.68 – 4.56	Dislike Slightly
3	2.79 – 3.67	Dislike Moderately
2	1.90 – 2.78	Dislike Very Much
1	1.00 – 1.89	Dislike Extremely

Ethical Consideration

The researcher used an informed consent that was explained to the respondents/evaluators, including the confidentiality agreement. The respondents were fully informed of the content of the evaluation sheet, how the data would be used, and what consequences it would have, including their rights to access information and the right to withdraw at any point without any pressure or coercion. The data gathered from the respondents were all treated with respect, in providing their opinions and answers to the questionnaire. The researcher also ensured that all research protocols for data collection were properly observed by the Data Privacy Act of 2012. They were also informed of the benefits of participating in the research and were aware that their involvement was free. The researchers acknowledge the main source of the adapted instrument.

RESULTS AND DISCUSSION

Microbial Analysis of Tebbeg-Yacon Wine

The tebbeg-yacon wine formulation was found to be free of microbes, and is safe for human consumption. This indicated that the wine produced was successfully free from *E. coli* and *molds,* which means that no pathogens were detected in the product. Microbial analysis plays a crucial role in winemaking by influencing fermentation, flavor, and stability.

Table 1. Microbial Analysis of Tebbeg-Yacon Wine

Product Sample Code	Detection of Pathogens	
	Escherichia coli	Molds
T1 – (tebbeg &yacon juice + water (1:2)	Negative	Negative
T2 - (tebbeg & yacon juice + water (1:1.5)	Negative	Negative
T3 – (tebbeg & yacon juice + water (1:1)	Negative	Negative
T4 – (tebbeg and Yacon juice + water (1:0.5)	Negative	Negative

The microbial analysis of the wine samples, prepared using varying ratios of *tebbeg* and yacon juice to water, revealed that all treatments tested negative for *Escherichia coli* and molds. This indicates that no detectable levels of these pathogens were present in any of the samples at the time of analysis.

The absence of *E. coli* suggests that the fermentation process and handling practices were conducted under adequate hygienic conditions, minimizing the risk of fecal contamination. Similarly, the lack of mold growth indicates that the samples were not exposed to fungal contamination, which could otherwise lead to spoilage or the production of harmful mycotoxins. These results also imply that the fermentation conditions—such as acidity, alcohol content, and possible antimicrobial compounds from *tebbeg* and yacon may have created an environment unfavorable for the growth of pathogenic microorganisms. This is consistent with the known inhibitory effects of low pH and ethanol in fermented beverages. Overall, the findings demonstrate that all wine formulations (T1–T4), regardless of dilution ratio, are microbiologically safe with respect to *E. coli* and molds, and meet basic safety expectations for fermented products. This supports the potential of *tebbeg* and yacon as suitable raw materials for safe wine production. In contrast to the results obtained from Bassey (2022), reaffirm that wine may develop unpleasant smells and odors from mold, as well as potentially dangerous substances like mycotoxins. Mold development is a sign of poor sanitation and control practices during the winemaking process. Nevertheless, mold contamination can happen when handling, fermenting, or storing fruit. This can cause odor and present a risk to consumer health. To avoid and manage mold growth, winemakers take extra precautions, including using sterile equipment, regulating temperature and humidity, and adding sulfur dioxide to the fermenter.

Table 2. Sensory Evaluation of Tebbeg-Yacon Wine

A. Visual Observation

a.1 Clarity. Clarity contributes to the overall visual appeal of the wine, which is an important factor in the tasting experience. It also describes a wine's reflective quality, such as whether it is clear, brilliant, hazy, or dull. It is an important visual quality parameter that influences the overall acceptability of wine, reflecting its brightness and absence of suspended particles. Based on the results, all treatments were generally well accepted, with mean ratings ranging from 6.71 to 7.54.

Among the samples, T2 (1:1.5 juice to water ratio) obtained the highest mean score of 7.54, described as "Like Very Much," indicating superior clarity compared to the other treatments. In contrast, T4 (1:0.5) recorded the lowest mean score of 6.71, corresponding to "Like Moderately," suggesting slightly reduced clarity, possibly due to higher juice concentration leading to more suspended solids.

The analysis of variance test result (ANOVA = 2.859*) indicates a significant difference among treatments. This means that the variation in dilution ratios had a statistically significant effect on the clarity of wine. The superscript letters further confirm that T2 differs significantly from some of the other treatments, particularly T4.

Overall, wines with moderate dilution (particularly T2) exhibited better clarity, which may be attributed to improved filtration, reduced turbidity, or more balanced composition during fermentation.

Table 2. Sensory Evaluation of Tebbeg-Yacon Wine

Clarity	Treatment	Mean	Description
	T1 – 1:2 (Juice + water)	7.46b	Like Very Much
	T2 – 1:1.5 (Juice + water)	7.54a	Like Very Much
	T3 – 1.1 (juice + water)	7.40bc	Like Very Much
	T4 – 1.0.5 (juice + water)	6.71 bcd)	Like Moderately
Anova – 2.859 *			
Color	Treatment	Mean	Description
	T1 – 1:2 (Juice + water)	6.97	Like Moderately
	T2 – 1:1.5 (Juice + water)	7.40	Like Very Much
	T3 – 1.1 (juice + water)	7.58	Like Very Much
	T4 – 1.0.5 (juice + water)	7.47	Like Very Much
Anova- 1.383 NS			

a.2. Color. Tebbeg-yacon wine typically exhibits its pearl-like yellow with little transparency, attributed to the high concentration of carotenoids that contribute to its yellow color. (Quinteros 2000. Color is another critical sensory attribute that affects consumer perception and acceptance of wine. The results show that all treatments were rated favorably, with mean scores ranging from 6.97 to 7.58.

T3 (1:1) obtained the highest mean score of 7.58, described as "Like Very Much," followed closely by T4 (7.47) and T2 (7.40), which were also rated "Like Very Much." T1 (1:2) had the lowest mean score of 6.97, corresponding to "Like Moderately." This suggests that wines with higher juice concentration tend to have more appealing color, likely due to increased pigment content from *tebbeg* and yacon.

However, the ANOVA result (1.383 NS) indicates no significant difference among treatments. This means that although there are slight variations in mean scores, the differences in color perception are not statistically significant and may be due to random variation rather than the effect of treatment.

The findings suggest that the dilution ratio significantly affects the clarity but does not significantly influence color. Moderate dilution (T2) appears optimal for clarity, while color remains generally acceptable across all formulations, with a slight preference for more concentrated juice blends.

Olfactory Observation

Intensity here relates to aroma, which means that a higher ratio of tebbeg-yacon juice to the formulations provides an intense smell. Intensity is a serious sensory attribute in wine, as it greatly influences consumer perception and overall acceptability. It encompasses both the intensity (strength) and type (quality or character) of the smell, which are primarily affected by fermentation processes and the composition of raw materials.

Table 3. Sensory Evaluation of Tebbeg-Yacon Wine in terms of intensity of smell and type of smell

Intensity of Smell	Treatment	Mean	Description
	T1 – 1:2 (Juice + water)	7.13	Like Moderately
	T2 – 1:1.5 (Juice + water)	6.63	Like Moderately
	T3 – 1.1 (juice + water)	7.33	Like Very Much
	T4 – 1.0.5 (juice + water)	6. 83	Like Moderately
Anova – .800 NS			
Type of Smell	Treatment	Mean	Description
	T1 – 1:2 (Juice + water)	6.41	Like Moderately
	T2 – 1:1.5 (Juice + water)	6.86	Like Moderately
	T3 – 1.1 (juice + water)	6.71	Like Moderately
	T4 – 1.0.5 (juice + water)	6.95	Like Moderately
Anova- .842 NS			

b.1. Intensity of Smell. The intensity of smell is powerful and has the potential to invoke strong emotions. The judge evaluates the product wine's finesse and elegance, its intensity, complexity, and persistence of aromas that spring from the glass. The depth of aroma includes the fineness of a wine, from its production, and evolution to its maturation, from the vine and zone of origin to the efforts and techniques used.
(http://www.winepassitaly.it/index.php)
The results show that the intensity of smell across all treatments ranged from 6.63 to 7.33, corresponding to "Like Moderately" to "Like Very Much." Among the samples, T3 (1:1 juice to water ratio) obtained the highest mean score of 7.33 ("Like Very Much"), indicating that this formulation produced the most desirable aroma strength. On the other hand, T2 (1:1.5) recorded the lowest mean score of 6.63, described as "Like Moderately." Despite these variations, the ANOVA result (0.800 NS) indicates no significant difference among treatments. This suggests that changes in dilution ratio did not significantly affect the perceived intensity of aroma. The relatively similar ratings may indicate that the fermentation process produced comparable levels of volatile aromatic compounds across all samples.

b.2. Type of Smell. In terms of aroma quality or type, all treatments received mean scores ranging from 6.41 to 6.95, consistently described as "Like Moderately." T4 (1:0.5) had the highest mean score (6.95), while T1 (1:2) had the lowest (6.41). This suggests that samples with higher juice concentration may have slightly more favorable aroma characteristics, possibly due to a richer composition of flavor precursors. However, the ANOVA test result (0.842 NS) also indicates no significant difference among treatments. This implies that the variation in juice-to-water ratios did not produce statistically distinct aroma profiles, and any observed differences were minimal.

The findings indicate that while slight differences exist in both the intensity and type of smell among the treatments, these variations are not statistically significant. This suggests that all formulations produced generally acceptable and comparable aromatic properties. The results further imply that the fermentation of *tebbeg* and yacon juice yields a stable aroma profile regardless of dilution ratio, with T3 showing a slight advantage in aroma intensity.

C. Tasting Observation

Taste is a critical determinant of wine quality and consumer acceptability, encompassing multiple attributes such as intensity, acidity, sweetness, body, texture, tannin, and aftertaste. The results demonstrate that varying the juice-to-water ratio significantly influenced several of these sensory parameters.

c.1. Intensity of Taste. The taste here refers to the extremeness of flavor and how the wine feels on the palate, and to get the full effect before swallowing. Among the taste evaluation of the tebbeg-yacon wine, the table also shows that the respondents distinctly favored the T_3 formulation with the highest mean rating of 7.68, which was described as "Like Very Much". This formulation resonated with the testers, indicating that the considerable ratio of tebbeg-yacon juice and water significantly enhanced the taste profile. The other treatments were described as "Like Moderately and Like Slightly". The ANOVA result (12.135*) indicates a significant difference among treatments, suggesting that increasing juice concentration enhances flavor intensity. The superscripts further confirm that T3 is significantly different from the other treatments.

c.2.Acidity. Acidity scores ranged from 6.28 to 6.70, all described as "Like Slightly" to "Like Moderately." T3 (6.70) had the highest rating, while T2 (6.28) had the lowest. However, the ANOVA result (0.531 NS) shows no significant difference, indicating that dilution levels did not significantly affect perceived acidity. This suggests a relatively stable acid balance across all formulations.

c.3.Sweetness. Sweetness varied notably among treatments, with T3 (7.89, "Like Very Much") receiving the highest rating and T1 (5.67) the lowest. The ANOVA (20.903*) reveals a highly significant difference, indicating that sweetness perception is strongly influenced by juice concentration. Higher juice content likely contributed more sugars, enhancing sweetness and acceptability.

Table 4. Sensory Evaluation of Tebbeg-Yacon Wine in terms of Tasting Observation

Intensity of Taste	Treatment	Mean	Description
	T1 – 1:2 (Juice + water)	5.66cd	Like Slightly
	T2 – 1:1.5 (Juice + water)	6.37c	Like Moderately
	T3 – 1.1 (juice + water)	7.68a	Like Very Much
	T4 – 1.0.5 (juice + water)	7.22b	Like Moderately
Anova – .12.135*			
Acidity	Treatment	Mean	Description
	T1 – 1:2 (Juice + water)	6.51	Like Moderately
	T2 – 1:1.5 (Juice + water)	6.28	Like Slightly
	T3 – 1.1 (juice + water)	6.70	Like Moderately
	T4 – 1.0.5 (juice + water)	6.68	Like Moderately
Anova- .0.531 NS			
Sweetness	Treatment	Mean	Description
	T1 – 1:2 (Juice + water)	5.67cd	Like Slightly
	T2 – 1:1.5 (Juice + water)	5.93c	Like Slightly
	T3 – 1.1 (juice + water)	7.89a	Like Very Much
	T4 – 1.0.5 (juice + water)	6.82b	Like Moderately
Anova- 20.903*			
Body	Treatment	Mean	Description
	T1 – 1:2 (Juice + water)	6.03cd	Like Slightly
	T2 – 1:1.5 (Juice + water)	6.10	Like Slightly
	T3 – 1.1 (juice + water)	7.89a	Like Very Much
	T4 – 1.0.5 (juice + water)	6.82b	Like Moderately
Anova- 9.220*			
Texture	Treatment	Mean	Description
	T1 – 1:2 (Juice + water)	6.38bcd	Like Moderately
	T2 – 1:1.5 (Juice + water)	6.49bc	Like Moderately
	T3 – 1.1 (juice + water)	7.39a	Like Very Much
	T4 – 1.0.5 (juice + water)	6.56b	Like Moderately
Anova- 3.331*			
Tannin	Treatment	Mean	Description
	T1 – 1:2 (Juice + water)	7.32ab	Like Very Much
	T2 – 1:1.5 (Juice + water)	5.91d	Like Slightly
	T3 – 1.1 (juice + water)	7.34a	Like Very Much
	T4 – 1.0.5 (juice + water)	6.75c	Like Moderately
Anova- 9.261*			
Aftertaste	Treatment	Mean	Description
	T1 – 1:2 (Juice + water)	6.26cd	Like Slightly
	T2 – 1:1.5 (Juice + water)	6.32c	Like Slightly
	T3 – 1.1 (juice + water)	7.33a	Like Very Much
	T4 – 1.0.5 (juice + water)	6.83bc	Like Moderately
Anova – 4.203*			

c.4. Body. Body refers to the fullness or weight of the wine in the mouth. T3 again achieved the highest score (7.89, "Like Very Much"), while T1 (6.03) and T2 (6.10) were rated lower ("Like Slightly"). The ANOVA ($p = 0.220*$) indicates a significant difference**,** suggesting that increased juice concentration improves the perceived richness and mouthfeel of the wine. c.5. Texture. Texture scores ranged from 6.38 to 7.39. T3 (7.39) was rated highest ("Like Very Much"), while the other treatments were described as "Like Moderately." The ANOVA result (3.331*) indicates a significant difference, meaning that formulation variations influenced the smoothness and consistency of the wine.

c.6. Tannin. Tannin perception showed notable variation, with T3 (7.34) and T1 (7.32) receiving the highest ratings ("Like Very Much"), while T2 (5.91) had the lowest ("Like Slightly"). The ANOVA (9.261*) confirms a significant difference among treatments. This suggests that both higher and lower dilution levels can influence tannin extraction and perception differently.

c.7. Aftertaste. Aftertaste scores ranged from 6.26 to 7.33. T3 (7.33, "Like Very Much") was most preferred, while T1 (6.26) and T2 (6.32) were less favored. The ANOVA result (4.203*) indicates a significant difference, showing that formulation affects the lingering flavor experience after consumption.

The results consistently show that T3 (1:1 juice to water ratio) achieved the highest ratings across most tasting attributes, including intensity, sweetness, body, texture, tannin, and aftertaste. This indicates that a balanced proportion of juice and water provides optimal sensory quality. In contrast, more diluted samples (T1 and T2) generally received lower ratings, suggesting reduced flavor richness and overall acceptability.

Overall, acidity was the only parameter that was not significantly affected by treatment, indicating stability across the formulations. Overall, the findings highlight that juice concentration plays a crucial role in enhancing the sensory characteristics of Tebbeg–Yacon wine, with T3 emerging as the most preferred formulation.

Physico-chemical Analysis of Tebbeg-Yacon Wine (Brix and Alcohol Content)

Brix (Sugar Content)

Brix values indicate the soluble solids (mainly sugars) in the wine, which are crucial for fermentation and alcohol production, and also indicate the ripeness of the fruit. The sugar content in fruits determines the potential alcohol level of the resulting wine, as sugars are converted to alcohol during fermentation (Howell, 2024). All the data presented have an initial Brix of 23^0, reflecting a similar sugar concentration in the juice blends. Treatment 3 (1:1 juice-to-water ratio) showed the lowest final Brix of 9^0, indicating the highest sugar consumption during fermentation. However, T1 and T2 both had a final Brix of 12^0, and T4 recorded 13^0. After 60 days of fermentation, the Brix values decreased as sugars were metabolized by yeast into ethanol. This also implies that the reduction in Brix reflects the efficiency of sugar conversion into alcohol, suggesting that T3 had the most complete fermentation. The higher remaining Brix in T4, therefore, indicates less sugar utilization, possibly due to dilution effects or limited yeast activity in higher juice concentrations. Howell (2024) affirms that the Brix level directly affects the potential alcohol content of the wine. Higher Brix levels indicate riper fruits and can result in wines with higher alcohol levels. This can impact the balance and perceived sweetness of the wine.

Table 5. Physico-chemical analysis of Tebbeg-Yacon Wine (Brix and Alcohol Content)

Product Sample Code	^{0}Brix (Original)	^{0}Brix (60 days after fermentation)	% Alcohol
T1 – (tebbeg &yacon juice + water (1:2)	23^0Brix	12^0B	4.4
T2 - (tebbeg & yacon juice + water (1.1.5)	23^0Brix	12^0B	4.3
T3 – (tebbeg & yacon juice + water (1:1)	23^0Brix	9^0B	8.5
T4 – (tebbeg and Yacon juice + water (1:0.5)	23^0Brix	13^0B	6.3

Alcohol Content (%)

Alcohol serves as a powerful flavor carrier in wine. It enhances the body, adds richness, and contributes to the overall balance of sweetness and acidity. Higher-alcohol wines often exhibit bold, intense flavors, while wines with lower alcohol levels tend to have a lighter, more delicate profile. https://thevineyard.wine

The percentage of alcohol produced correlates with sugar consumption during fermentation, as shown by the result that T3 produced the highest alcohol content of 8.5%, corresponding with the largest drop in Brix. Likewise, T4 had 6.3% while T1 and T2 yielded lower Alcohol Contents of 4.4% and 4.3%, respectively. This indicates that the 1:1 juice-to-water ratio (T3) is optimal for achieving maximum alcohol production, as it balances sugar concentration for efficient fermentation without over-concentration or inhibition of yeast activity. Samples with higher dilution (T1 and T2) had lower sugar concentration per unit volume, resulting in lower ethanol yields. Conversely, T4, despite a higher juice concentration, may have had suboptimal yeast efficiency due to osmotic stress or other fermentation factors.

The physicochemical analysis reveals that fermentation efficiency and alcohol production in Tebbeg–Yacon wine are significantly influenced by the juice-to-water ratio. T3 (1:1) emerged as the most efficient formulation, showing the largest reduction in Brix and the highest alcohol content, which aligns with the superior sensory ratings observed in previous evaluations (taste, body, sweetness). This suggests that both sugar availability and proper dilution are critical to producing a balanced and high-quality wine from Tebbeg and Yacon juice. Ottaiano (2025 confirms that alcohol plays a pivotal role in wine, contributing significantly to its flavor and mouthfeel. It adds richness and body, creating a fuller, rounder sensation in your mouth. Wines with higher alcohol content tend to have a robust, bold flavor, while those with lower alcohol levels often exhibit a lighter, more delicate profile. Moreover, alcohol acts as a solvent, extracting and releasing various flavors and aromas from the grapes during the fermentation process. This enhances the complexity of the wine, adding layers of depth to its profile.

CONCLUSIONS

1. All Tebbeg–Yacon wine formulations (T1–T4) were free from *Escherichia coli* and molds, indicating that the wines are microbiologically safe for consumption.
2. Among the four formulations, T3 (1:1 juice-to-water ratio) consistently achieved the highest ratings across key sensory attributes, including taste intensity, sweetness, body, texture, tannin, aftertaste, and aroma. This suggests that a balanced juice-to-water ratio produces the most acceptable and preferred wine.
3. T3 also demonstrated the most efficient fermentation, as evidenced by the largest reduction in Brix (sugar content) and the highest alcohol content (8.5%). Other formulations showed less sugar utilization and lower ethanol yield, likely due to either over-dilution or suboptimal juice concentration.
4. The study confirms that Tebbeg and Yacon juice can be successfully fermented into a functional wine with desirable sensory and physicochemical characteristics. Moderate dilution (1:1) provides the best balance for taste, alcohol content, and overall acceptability.

RECOMMENDATIONS

1. For commercial or household production of Tebbeg–Yacon wine, the 1:1 juice-to-water ratio (T3) is recommended to achieve the best balance of sensory quality and alcohol content.
2. Maintain hygienic practices during processing to ensure microbial safety, and monitor fermentation parameters such as sugar content and pH to achieve consistent product quality.
3. Investigate the shelf life and storage stability of Tebbeg–Yacon wine.
4. Explore nutritional and functional properties, such as antioxidant activity and prebiotic effects from Yacon.
5. Experiment with fermentation enhancers or yeast strains to optimize alcohol yield and sensory profile further.
6. Consider producing Tebbeg–Yacon wine as a functional beverage due to its potential health benefits and unique flavor profile, which could appeal to niche markets seeking novel fermented drinks.

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APPENDICES

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Clarity	Between Groups	12.782	3	4.261	2.859	.040
	Within Groups	171.387	115	1.490		
	Total	184.169	118			
Sweetness	Between Groups	96.214	3	32.071	20.903	.000
	Within Groups	176.442	115	1.534		
	Total	272.656	118			
Body	Between Groups	42.575	3	14.192	9.220	.000
	Within Groups	177.003	115	1.539		
	Total	219.578	118			
Texture	Between Groups	19.210	3	6.403	3.331	.022
	Within Groups	221.091	115	1.923		
	Total	240.301	118			
Tannin	Between Groups	40.743	3	13.581	9.761	.000
	Within Groups	160.015	115	1.391		
	Total	200.759	118			
Aftertaste	Between Groups	22.552	3	7.517	4.203	.007
	Within Groups	205.668	115	1.788		
	Total	228.221	118			
Color	Between Groups	6.458	3	2.153	1.383	.251
	Within Groups	178.953	115	1.556		
	Total	185.410	118			
I.Smell	Between Groups	4.726	3	1.575	.800	.496
	Within Groups	226.525	115	1.970		
	Total	231.251	118			
T.smell	Between Groups	4.982	3	1.661	.842	.474
	Within Groups	226.964	115	1.974		
	Total	231.947	118			
I.Taste	Between Groups	72.318	3	24.106	12.135	.000
	Within Groups	228.454	115	1.987		
	Total	300.772	118			

Acidity	Between Groups	3.410	3	1.137	.531	.662
	Within Groups	246.228	115	2.141		
	Total	249.638	118			

Multiple Comparisons

Dependent Variable		(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Clarity	Tukey HSD	1.00	2.00	-.08867	.31521	.992	-.9104	.7331
			3.00	.05600	.31521	.998	-.7657	.8777
			4.00	.74292	.31791	.096	-.0859	1.5717
		2.00	1.00	.08867	.31521	.992	-.7331	.9104
			3.00	.14467	.31521	.968	-.6771	.9664
			4.00	.83159*	.31791	.049	.0028	1.6604
		3.00	1.00	-.05600	.31521	.998	-.8777	.7657
			2.00	-.14467	.31521	.968	-.9664	.6771
			4.00	.68692	.31791	.141	-.1419	1.5157
		4.00	1.00	-.74292	.31791	.096	-1.5717	.0859
			2.00	-.83159*	.31791	.049	-1.6604	-.0028
			3.00	-.68692	.31791	.141	-1.5157	.1419
	LSD	1.00	2.00	-.08867	.31521	.779	-.7130	.5357
			3.00	.05600	.31521	.859	-.5684	.6804
			4.00	.74292*	.31791	.021	.1132	1.3726
		2.00	1.00	.08867	.31521	.779	-.5357	.7130
			3.00	.14467	.31521	.647	-.4797	.7690
			4.00	.83159*	.31791	.010	.2019	1.4613
		3.00	1.00	-.05600	.31521	.859	-.6804	.5684
			2.00	-.14467	.31521	.647	-.7690	.4797
			4.00	.68692*	.31791	.033	.0572	1.3166
		4.00	1.00	-.74292*	.31791	.021	-1.3726	-.1132
			2.00	-.83159*	.31791	.010	-1.4613	-.2019
			3.00	-.68692*	.31791	.033	-1.3166	-.0572
Sweetness	Tukey HSD	1.00	2.00	-.36600	.31982	.663	-1.1998	.4678
			3.00	-2.32167*	.31982	.000	-3.1554	-1.4879
			4.00	-1.24851*	.32257	.001	-2.0894	-.4076
		2.00	1.00	.36600	.31982	.663	-.4678	1.1998
			3.00	-1.95567*	.31982	.000	-2.7894	-1.1219
			4.00	-.88251*	.32257	.036	-1.7234	-.0416
		3.00	1.00	2.32167*	.31982	.000	1.4879	3.1554
			2.00	1.95567*	.31982	.000	1.1219	2.7894
			4.00	1.07316*	.32257	.006	.2322	1.9141
		4.00	1.00	1.24851*	.32257	.001	.4076	2.0894
			2.00	.88251*	.32257	.036	.0416	1.7234
			3.00	-1.07316*	.32257	.006	-1.9141	-.2322
	LSD	1.00	2.00	-.36600	.31982	.255	-.9995	.2675
			3.00	-2.32167*	.31982	.000	-2.9552	-1.6882
			4.00	-1.24851*	.32257	.000	-1.8874	-.6096
		2.00	1.00	.36600	.31982	.255	-.2675	.9995
			3.00	-1.95567*	.31982	.000	-2.5892	-1.3222
			4.00	-.88251*	.32257	.007	-1.5214	-.2436
		3.00	1.00	2.32167*	.31982	.000	1.6882	2.9552
			2.00	1.95567*	.31982	.000	1.3222	2.5892
			4.00	1.07316*	.32257	.001	.4342	1.7121
		4.00	1.00	1.24851*	.32257	.000	.6096	1.8874

			2.00	.88251*	.32257	.007	.2436	1.5214
			3.00	-1.07316*	.32257	.001	-1.7121	-.4342
Body	Tukey HSD	1.00	2.00	-.06700	.32033	.997	-.9021	.7681
			3.00	-1.34367*	.32033	.000	-2.1788	-.5086
			4.00	-1.08080*	.32308	.006	-1.9231	-.2385
		2.00	1.00	.06700	.32033	.997	-.7681	.9021
			3.00	-1.27667*	.32033	.001	-2.1118	-.4416
			4.00	-1.01380*	.32308	.011	-1.8561	-.1715
		3.00	1.00	1.34367*	.32033	.000	.5086	2.1788
			2.00	1.27667*	.32033	.001	.4416	2.1118
			4.00	.26286	.32308	.848	-.5794	1.1051
		4.00	1.00	1.08080*	.32308	.006	.2385	1.9231
			2.00	1.01380*	.32308	.011	.1715	1.8561
			3.00	-.26286	.32308	.848	-1.1051	.5794
	LSD	1.00	2.00	-.06700	.32033	.835	-.7015	.5675
			3.00	-1.34367*	.32033	.000	-1.9782	-.7092
			4.00	-1.08080*	.32308	.001	-1.7208	-.4408
		2.00	1.00	.06700	.32033	.835	-.5675	.7015
			3.00	-1.27667*	.32033	.000	-1.9112	-.6422
			4.00	-1.01380*	.32308	.002	-1.6538	-.3738
		3.00	1.00	1.34367*	.32033	.000	.7092	1.9782
			2.00	1.27667*	.32033	.000	.6422	1.9112
			4.00	.26286	.32308	.418	-.3771	.9028
		4.00	1.00	1.08080*	.32308	.001	.4408	1.7208
			2.00	1.01380*	.32308	.002	.3738	1.6538
			3.00	-.26286	.32308	.418	-.9028	.3771
Texture	Tukey HSD	1.00	2.00	-.11067	.35801	.990	-1.0440	.8227
			3.00	-1.01033*	.35801	.028	-1.9437	-.0770
			4.00	-.18441	.36108	.956	-1.1257	.7569
		2.00	1.00	.11067	.35801	.990	-.8227	1.0440
			3.00	-.89967	.35801	.063	-1.8330	.0337
			4.00	-.07375	.36108	.997	-1.0151	.8676
		3.00	1.00	1.01033*	.35801	.028	.0770	1.9437
			2.00	.89967	.35801	.063	-.0337	1.8330
			4.00	.82592	.36108	.107	-.1154	1.7673
		4.00	1.00	.18441	.36108	.956	-.7569	1.1257
			2.00	.07375	.36108	.997	-.8676	1.0151
			3.00	-.82592	.36108	.107	-1.7673	.1154
	LSD	1.00	2.00	-.11067	.35801	.758	-.8198	.5985
			3.00	-1.01033*	.35801	.006	-1.7195	-.3012
			4.00	-.18441	.36108	.611	-.8996	.5308
		2.00	1.00	.11067	.35801	.758	-.5985	.8198
			3.00	-.89967*	.35801	.013	-1.6088	-.1905
			4.00	-.07375	.36108	.839	-.7890	.6415
		3.00	1.00	1.01033*	.35801	.006	.3012	1.7195
			2.00	.89967*	.35801	.013	.1905	1.6088
			4.00	.82592*	.36108	.024	.1107	1.5411
		4.00	1.00	.18441	.36108	.611	-.5308	.8996
			2.00	.07375	.36108	.839	-.6415	.7890
			3.00	-.82592*	.36108	.024	-1.5411	-.1107
Tannin	Tukey HSD	1.00	2.00	1.41100*	.30457	.000	.6170	2.2050
			3.00	-.02267	.30457	1.000	-.8167	.7713
			4.00	.57478	.30718	.246	-.2260	1.3756
		2.00	1.00	-1.41100*	.30457	.000	-2.2050	-.6170

			3.00	-1.43367*	.30457	.000	-2.2277	-.6397
			4.00	-.83622*	.30718	.037	-1.6370	-.0354
		3.00	1.00	.02267	.30457	1.000	-.7713	.8167
			2.00	1.43367*	.30457	.000	.6397	2.2277
			4.00	.59745	.30718	.215	-.2034	1.3983
		4.00	1.00	-.57478	.30718	.246	-1.3756	.2260
			2.00	.83622*	.30718	.037	.0354	1.6370
			3.00	-.59745	.30718	.215	-1.3983	.2034
	LSD	1.00	2.00	1.41100*	.30457	.000	.8077	2.0143
			3.00	-.02267	.30457	.941	-.6260	.5806
			4.00	.57478	.30718	.064	-.0337	1.1833
		2.00	1.00	-1.41100*	.30457	.000	-2.0143	-.8077
			3.00	-1.43367*	.30457	.000	-2.0370	-.8304
			4.00	-.83622*	.30718	.007	-1.4447	-.2277
		3.00	1.00	.02267	.30457	.941	-.5806	.6260
			2.00	1.43367*	.30457	.000	.8304	2.0370
			4.00	.59745	.30718	.054	-.0110	1.2059
		4.00	1.00	-.57478	.30718	.064	-1.1833	.0337
			2.00	.83622*	.30718	.007	.2277	1.4447
			3.00	-.59745	.30718	.054	-1.2059	.0110
Aftertaste	Tukey HSD	1.00	2.00	-.06667	.34529	.997	-.9668	.8335
			3.00	-1.07467*	.34529	.012	-1.9748	-.1745
			4.00	-.57122	.34826	.360	-1.4791	.3367
		2.00	1.00	.06667	.34529	.997	-.8335	.9668
			3.00	-1.00800*	.34529	.022	-1.9082	-.1078
			4.00	-.50455	.34826	.472	-1.4125	.4034
		3.00	1.00	1.07467*	.34529	.012	.1745	1.9748
			2.00	1.00800*	.34529	.022	.1078	1.9082
			4.00	.50345	.34826	.474	-.4045	1.4114
		4.00	1.00	.57122	.34826	.360	-.3367	1.4791
			2.00	.50455	.34826	.472	-.4034	1.4125
			3.00	-.50345	.34826	.474	-1.4114	.4045
	LSD	1.00	2.00	-.06667	.34529	.847	-.7506	.6173
			3.00	-1.07467*	.34529	.002	-1.7586	-.3907
			4.00	-.57122	.34826	.104	-1.2611	.1186
		2.00	1.00	.06667	.34529	.847	-.6173	.7506
			3.00	-1.00800*	.34529	.004	-1.6920	-.3240
			4.00	-.50455	.34826	.150	-1.1944	.1853
		3.00	1.00	1.07467*	.34529	.002	.3907	1.7586
			2.00	1.00800*	.34529	.004	.3240	1.6920
			4.00	.50345	.34826	.151	-.1864	1.1933
		4.00	1.00	.57122	.34826	.104	-.1186	1.2611
			2.00	.50455	.34826	.150	-.1853	1.1944
			3.00	-.50345	.34826	.151	-1.1933	.1864
Color	Tukey HSD	1.00	2.00	-.43333	.32209	.536	-1.2730	.4063
			3.00	-.61067	.32209	.236	-1.4503	.2290
			4.00	-.50436	.32485	.410	-1.3512	.3425
		2.00	1.00	.43333	.32209	.536	-.4063	1.2730
			3.00	-.17733	.32209	.946	-1.0170	.6623
			4.00	-.07102	.32485	.996	-.9179	.7759
		3.00	1.00	.61067	.32209	.236	-.2290	1.4503
			2.00	.17733	.32209	.946	-.6623	1.0170
			4.00	.10631	.32485	.988	-.7406	.9532
		4.00	1.00	.50436	.32485	.410	-.3425	1.3512

			2.00	.07102	.32485	.996	-.7759	.9179
			3.00	-.10631	.32485	.988	-.9532	.7406
	LSD	1.00	2.00	-.43333	.32209	.181	-1.0713	.2047
			3.00	-.61067	.32209	.060	-1.2487	.0273
			4.00	-.50436	.32485	.123	-1.1478	.1391
		2.00	1.00	.43333	.32209	.181	-.2047	1.0713
			3.00	-.17733	.32209	.583	-.8153	.4607
			4.00	-.07102	.32485	.827	-.7145	.5724
		3.00	1.00	.61067	.32209	.060	-.0273	1.2487
			2.00	.17733	.32209	.583	-.4607	.8153
			4.00	.10631	.32485	.744	-.5372	.7498
		4.00	1.00	.50436	.32485	.123	-.1391	1.1478
			2.00	.07102	.32485	.827	-.5724	.7145
			3.00	-.10631	.32485	.744	-.7498	.5372
I.Smell	Tukey HSD	1.00	2.00	.50100	.36238	.513	-.4437	1.4457
			3.00	.05667	.36238	.999	-.8881	1.0014
			4.00	.08815	.36549	.995	-.8647	1.0410
		2.00	1.00	-.50100	.36238	.513	-1.4457	.4437
			3.00	-.44433	.36238	.612	-1.3891	.5004
			4.00	-.41285	.36549	.672	-1.3657	.5400
		3.00	1.00	-.05667	.36238	.999	-1.0014	.8881
			2.00	.44433	.36238	.612	-.5004	1.3891
			4.00	.03148	.36549	1.000	-.9213	.9843
		4.00	1.00	-.08815	.36549	.995	-1.0410	.8647
			2.00	.41285	.36549	.672	-.5400	1.3657
			3.00	-.03148	.36549	1.000	-.9843	.9213
	LSD	1.00	2.00	.50100	.36238	.169	-.2168	1.2188
			3.00	.05667	.36238	.876	-.6611	.7745
			4.00	.08815	.36549	.810	-.6358	.8121
		2.00	1.00	-.50100	.36238	.169	-1.2188	.2168
			3.00	-.44433	.36238	.223	-1.1621	.2735
			4.00	-.41285	.36549	.261	-1.1368	.3111
		3.00	1.00	-.05667	.36238	.876	-.7745	.6611
			2.00	.44433	.36238	.223	-.2735	1.1621
			4.00	.03148	.36549	.932	-.6925	.7554
		4.00	1.00	-.08815	.36549	.810	-.8121	.6358
			2.00	.41285	.36549	.261	-.3111	1.1368
			3.00	-.03148	.36549	.932	-.7554	.6925
T.smell	Tukey HSD	1.00	2.00	-.44467	.36273	.612	-1.3903	.5010
			3.00	-.29867	.36273	.843	-1.2443	.6470
			4.00	-.54210	.36584	.452	-1.4959	.4117
		2.00	1.00	.44467	.36273	.612	-.5010	1.3903
			3.00	.14600	.36273	.978	-.7996	1.0916
			4.00	-.09744	.36584	.993	-1.0512	.8563
		3.00	1.00	.29867	.36273	.843	-.6470	1.2443
			2.00	-.14600	.36273	.978	-1.0916	.7996
			4.00	-.24344	.36584	.910	-1.1972	.7103
		4.00	1.00	.54210	.36584	.452	-.4117	1.4959
			2.00	.09744	.36584	.993	-.8563	1.0512
			3.00	.24344	.36584	.910	-.7103	1.1972
	LSD	1.00	2.00	-.44467	.36273	.223	-1.1632	.2738
			3.00	-.29867	.36273	.412	-1.0172	.4198
			4.00	-.54210	.36584	.141	-1.2668	.1826

		2.00	1.00	.44467	.36273	.223	-.2738	1.1632
			3.00	.14600	.36273	.688	-.5725	.8645
			4.00	-.09744	.36584	.790	-.8221	.6272
		3.00	1.00	.29867	.36273	.412	-.4198	1.0172
			2.00	-.14600	.36273	.688	-.8645	.5725
			4.00	-.24344	.36584	.507	-.9681	.4812
		4.00	1.00	.54210	.36584	.141	-.1826	1.2668
			2.00	.09744	.36584	.790	-.6272	.8221
			3.00	.24344	.36584	.507	-.4812	.9681
I.Taste	Tukey HSD	1.00	2.00	-.70867	.36392	.214	-1.6574	.2401
			3.00	-2.02000*	.36392	.000	-2.9687	-1.0713
			4.00	-1.56060*	.36704	.000	-2.5175	-.6037
		2.00	1.00	.70867	.36392	.214	-.2401	1.6574
			3.00	-1.31133*	.36392	.003	-2.2601	-.3626
			4.00	-.85193	.36704	.099	-1.8088	.1049
		3.00	1.00	2.02000*	.36392	.000	1.0713	2.9687
			2.00	1.31133*	.36392	.003	.3626	2.2601
			4.00	.45940	.36704	.595	-.4975	1.4163
		4.00	1.00	1.56060*	.36704	.000	.6037	2.5175
			2.00	.85193	.36704	.099	-.1049	1.8088
			3.00	-.45940	.36704	.595	-1.4163	.4975
	LSD	1.00	2.00	-.70867	.36392	.054	-1.4295	.0122
			3.00	-2.02000*	.36392	.000	-2.7409	-1.2991
			4.00	-1.56060*	.36704	.000	-2.2876	-.8336
		2.00	1.00	.70867	.36392	.054	-.0122	1.4295
			3.00	-1.31133*	.36392	.000	-2.0322	-.5905
			4.00	-.85193*	.36704	.022	-1.5790	-.1249
		3.00	1.00	2.02000*	.36392	.000	1.2991	2.7409
			2.00	1.31133*	.36392	.000	.5905	2.0322
			4.00	.45940	.36704	.213	-.2676	1.1864
		4.00	1.00	1.56060*	.36704	.000	.8336	2.2876
			2.00	.85193*	.36704	.022	.1249	1.5790
			3.00	-.45940	.36704	.213	-1.1864	.2676
Acidity	Tukey HSD	1.00	2.00	.23467	.37781	.925	-.7503	1.2196
			3.00	-.18767	.37781	.960	-1.1726	.7973
			4.00	-.16591	.38105	.972	-1.1593	.8275
		2.00	1.00	-.23467	.37781	.925	-1.2196	.7503
			3.00	-.42233	.37781	.679	-1.4073	.5626
			4.00	-.40057	.38105	.720	-1.3940	.5928
		3.00	1.00	.18767	.37781	.960	-.7973	1.1726
			2.00	.42233	.37781	.679	-.5626	1.4073
			4.00	.02176	.38105	1.000	-.9716	1.0152
		4.00	1.00	.16591	.38105	.972	-.8275	1.1593
			2.00	.40057	.38105	.720	-.5928	1.3940
			3.00	-.02176	.38105	1.000	-1.0152	.9716
	LSD	1.00	2.00	.23467	.37781	.536	-.5137	.9830
			3.00	-.18767	.37781	.620	-.9360	.5607
			4.00	-.16591	.38105	.664	-.9207	.5889
		2.00	1.00	-.23467	.37781	.536	-.9830	.5137
			3.00	-.42233	.37781	.266	-1.1707	.3260
			4.00	-.40057	.38105	.295	-1.1554	.3542
		3.00	1.00	.18767	.37781	.620	-.5607	.9360

			2.00	.42233	.37781	.266	-.3260	1.1707
			4.00	.02176	.38105	.955	-.7330	.7766
		4.00	1.00	.16591	.38105	.664	-.5889	.9207
			2.00	.40057	.38105	.295	-.3542	1.1554
			3.00	-.02176	.38105	.955	-.7766	.7330
*. The mean difference is significant at the 0.05 level.								

Clarity				
	Treatment	N	Subset for alpha = 0.05	
			1	2
Tukey HSD[a,b]	4.00	29	6.7124	
	3.00	30	7.3993	7.3993
	1.00	30	7.4553	7.4553
	2.00	30		7.5440
	Sig.		.094	.968
Duncan[a,b]	4.00	29	6.7124	
	3.00	30		7.3993
	1.00	30		7.4553
	2.00	30		7.5440
	Sig.		1.000	.670
Means for groups in homogeneous subsets are displayed.				
a. Uses Harmonic Mean Sample Size = 29.744.				
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.				

Sweetness					
	Treatment	N	Subset for alpha = 0.05		
			1	2	3
Tukey HSD[a,b]	1.00	30	5.5667		
	2.00	30	5.9327		
	4.00	29		6.8152	
	3.00	30			7.8883
	Sig.		.666	1.000	1.000
Duncan[a,b]	1.00	30	5.5667		
	2.00	30	5.9327		
	4.00	29		6.8152	
	3.00	30			7.8883
	Sig.		.257	1.000	1.000
Means for groups in homogeneous subsets are displayed.					
a. Uses Harmonic Mean Sample Size = 29.744.					
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.					

Body				
	Treatment	N	Subset for alpha = 0.05	
			1	2

Tukey HSD[a,b]	1.00	30	6.0333	
	2.00	30	6.1003	
	4.00	29		7.1141
	3.00	30		7.3770
	Sig.		.997	.846
Duncan[a,b]	1.00	30	6.0333	
	2.00	30	6.1003	
	4.00	29		7.1141
	3.00	30		7.3770
	Sig.		.835	.416
Means for groups in homogeneous subsets are displayed.				
a. Uses Harmonic Mean Sample Size = 29.744.				
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.				

Texture				
	Treatment	N	Subset for alpha = 0.05	
			1	2
Tukey HSD[a,b]	1.00	30	6.3780	
	2.00	30	6.4887	6.4887
	4.00	29	6.5624	6.5624
	3.00	30		7.3883
	Sig.		.956	.065
Duncan[a,b]	1.00	30	6.3780	
	2.00	30	6.4887	
	4.00	29	6.5624	
	3.00	30		7.3883
	Sig.		.633	1.000
Means for groups in homogeneous subsets are displayed.				
a. Uses Harmonic Mean Sample Size = 29.744.				
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.				

Tannin				
	Treatment	N	Subset for alpha = 0.05	
			1	2
Tukey HSD[a,b]	2.00	30	5.9103	
	4.00	29		6.7466
	1.00	30		7.3213
	3.00	30		7.3440
	Sig.		1.000	.212
Duncan[a,b]	2.00	30	5.9103	
	4.00	29		6.7466
	1.00	30		7.3213
	3.00	30		7.3440
	Sig.		1.000	.067
Means for groups in homogeneous subsets are displayed.				

a. Uses Harmonic Mean Sample Size = 29.744.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Aftertaste				
	Treatment	N	Subset for alpha = 0.05	
			1	2
Tukey HSD[a,b]	1.00	30	6.2553	
	2.00	30	6.3220	
	4.00	29	6.8266	6.8266
	3.00	30		7.3300
	Sig.		.357	.470
Duncan[a,b]	1.00	30	6.2553	
	2.00	30	6.3220	
	4.00	29	6.8266	6.8266
	3.00	30		7.3300
	Sig.		.123	.149
Means for groups in homogeneous subsets are displayed.				
a. Uses Harmonic Mean Sample Size = 29.744.				
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.				

Color			
	Treatment	N	Subset for alpha = 0.05
			1
Tukey HSD[a,b]	1.00	30	6.9663
	2.00	30	7.3997
	4.00	29	7.4707
	3.00	30	7.5770
	Sig.		.239
Duncan[a,b]	1.00	30	6.9663
	2.00	30	7.3997
	4.00	29	7.4707
	3.00	30	7.5770
	Sig.		.087
Means for groups in homogeneous subsets are displayed.			
a. Uses Harmonic Mean Sample Size = 29.744.			
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.			

I.Smell			
	Treatment	N	Subset for alpha = 0.05
			1

Tukey HSD[a,b]	2.00	30	6.6327
	4.00	29	7.0455
	3.00	30	7.0770
	1.00	30	7.1337
	Sig.		.517
Duncan[a,b]	2.00	30	6.6327
	4.00	29	7.0455
	3.00	30	7.0770
	1.00	30	7.1337
	Sig.		.215
Means for groups in homogeneous subsets are displayed.			
a. Uses Harmonic Mean Sample Size = 29.744.			
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.			

T.smell			
	Treatment	N	Subset for alpha = 0.05
			1
Tukey HSD[a,b]	1.00	30	6.4110
	3.00	30	6.7097
	2.00	30	6.8557
	4.00	29	6.9531
	Sig.		.448
Duncan[a,b]	1.00	30	6.4110
	3.00	30	6.7097
	2.00	30	6.8557
	4.00	29	6.9531
	Sig.		.180
Means for groups in homogeneous subsets are displayed.			
a. Uses Harmonic Mean Sample Size = 29.744.			
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.			

I.Taste					
	Treatment	N	Subset for alpha = 0.05		
			1	2	3
Tukey HSD[a,b]	1.00	30	5.6573		
	2.00	30	6.3660	6.3660	
	4.00	29		7.2179	7.2179
	3.00	30			7.6773
	Sig.		.218	.097	.592
Duncan[a,b]	1.00	30	5.6573		
	2.00	30	6.3660		
	4.00	29		7.2179	
	3.00	30		7.6773	
	Sig.		.055	.211	

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 29.744.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Acidity			
	Treatment	N	Subset for alpha = 0.05
			1
Tukey HSD[a,b]	2.00	30	6.2767
	1.00	30	6.5113
	4.00	29	6.6772
	3.00	30	6.6990
	Sig.		.682
Duncan[a,b]	2.00	30	6.2767
	1.00	30	6.5113
	4.00	29	6.6772
	3.00	30	6.6990
	Sig.		.318
Means for groups in homogeneous subsets are displayed.			
a. Uses Harmonic Mean Sample Size = 29.744.			
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.			