Chapter 16

Development of a Novel Sorghum and Prickly Pear-Infused Cream Liqueur (Afro- Craft)

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Abstract

This study presents the development and characterisation of a novel sorghum- and prickly pear-infused cream liqueur, a unique and innovative alcoholic beverage that combines the natural sweetness of sorghum with the delicate flavour of prickly pears. The increasing demand for craft spirits, exotic ingredients and unique flavour profiles drives the need for innovative products that cater to these trends.

To increase the surface area for the enzymatic action of the sorghum grains, the grinding method was used. For the conversion of starch and gelatinisation, the cooking method was applied. To increase the number of fermentable sugars, sucrose was added. The saccharified mash was cooled and filtered, and the wort was further used for processing. A selected yeast strain (*Saccharomyces cerevisiae*) was added to the wort. The fermentation process was performed by incubating the wort at 32 °C for 8 days. The prickly pear was naturally fermented for 5 days. A stabiliser and flavour enhancers were integrated. For quality tests, an alcoliser, a pH metre and a refractometer were used. For sensory evaluation, a taste panel evaluation method was used to evaluate the acceptability of the products.

Analysis revealed that the use of yeast extract in the fermentation process enhanced the flavour profile of the final product and thus created a distinct aroma. The process of cooking sorghum mash results in a creamier product, whereas the addition of fermented prickly pear results in a well-rounded flavour. The use of xanthan gum as a stabiliser applied at 0.25% was able to prevent the product from separating upon storage. The eight-day fermentation period of sorghum wort yielded an alcohol by volume (ABV) of 15.3%, which was within the target range. The product had a smooth and creamy mouthfeel with brown, beige milky colouration that was acceptable. The pH and Brix of the product were 3.6 and 35%, respectively.

In this study, cream liqueur was developed using sorghum and prickly pears, which were stabilised with xanthan gum and pasteurised for safety. The unique flavour profile and texture of the liqueur were evaluated, revealing high acceptability and potential commercialisation. This research demonstrated the feasibility of using these ingredients as alternatives to traditional ingredients.

Keywords: *Sorghum, Prickly pear, Cream liqueur, Fermentation and Unique flavour profiles*

Introduction

Prickly pear-infused sorghum-based cream liqueur is a modernised traditional beer inspired by the well-known *umqombothi* and the well-known Amarula. It introduces the union of traditional and modern themes within the alcoholic beverage sector. It is produced from fermenting malted sorghum, which is indigenous to Africa, and prickly pears, which are not utilised in beer production.

Rural areas in South Africa have a rich tradition of consuming sorghum beer, a traditional alcoholic beverage. While sorghum beer is popular, there is an emerging preference for beverages with a creamy texture (Ogunremi et al., 2022). Existing options do not blend the traditional flavours of sorghum with the desired creamy texture, creating a gap in the market (Gungor et al., 2024). Current options have

a limited availability of premium, locally sourced liquids with unique flavours in the market. Customer needs include the desire for high-quality, distinctive beverages that showcase local ingredients and craftsmanship (Apud et al., 2024).

The current emotional impact caused by the identified problem in the market includes the desire for a more refined, creamy texture that remains unfulfilled and has limited variety in traditional alcoholic beverages (Agarbati et al., 2024). The current quantifiable impact includes the willingness of consumers to pay a premium for high-quality, unique products. Cultural impact includes the preservation and promotion of South African cultural ingredients, which are prickly pear and sorghum. The target market for this product idea would be the public, including those of legal drinking age, primarily those who already enjoy sorghum beer, traditional flavours, creamy textures, and locally sourced ingredients. It is also targeted at consumers who crave a premium drinking experience with unique flavours and seek products that can be shared and appreciated in social settings.

The science behind the product idea lies in the fermentation of malted sorghum grains with prickly pears and the creation of cream liqueur emulsions. The sorghum grains are soaked in water to initiate germination; this step is crucial, as it activates enzymes within the grains. During sorghum alcohol fermentation, carbohydrates in the grain are fermented by yeast to produce ethanol and carbon dioxide (Hlangwani et al., 2023). Traditional alcoholic beverages such as sorghum beer are often made using this method, which is comparable to the fermentation of other grains (Hlangwani et al., 2023). South Africa has a long and rich history of sorghum fermentation, as this grain has been a mainstay of many cultures' diets for ages (Shumye Gebre et al., 2024).

Prickly pears are juiced or pureed to extract sugars, vitamins, and aromatic compounds, and the juice contains natural sugars such as glucose and fructose, which are fermentable by yeast (Yang et al., 2023). Prickly pear is an edible cactus fruit that is tasty and sweet and has many health benefits. It has been a staple in Mexican cooking for a long time, and its use has spread

throughout the southwest America and beyond. The fruit of the prickly pear tree is used in drinks, juices, jams, and other recipes, and the plant is edible in many areas (Xolo et al., 2024). Prickly pear fermentation involves the microbiological transformation of its natural sugars, primarily glucose and fructose, into alcohol or lactic acid by yeast and lactic acid bacteria. While specific studies on prickly pear fermentation are scarce, general principles indicate that this procedure can enhance a fruit's flavour profile by creating esters, alcohols, and organic acids (Hlangwani et al., 2023). The acidity of the finished product may increase, aiding in preservation and impacting taste. Furthermore, fermentation may modify the antioxidant profile and polyphenolic components in prickly pears, affecting their bioavailability and function (Adekoya et al., 2019).

The aim of this research is to develop a sorghum and prickly pear-infused cream liqueur recipe, evaluate the sensory and cultural acceptability of the liqueur among target consumers and assess the feasibility and viability of large-scale production and market entry.

Materials and Methods

Materials

The following materials were used: malted sorghum grains, brown sugar, prickly pears and condensed milk. Yeast extract, caramel syrup E150, vanilla extract and xanthan gum. The following equipment was provided by Givaudan South Africa (Pty) Ltd: incubator, balance and analytical scales, glass beakers, metallic bowls, cheesecloth, food processor, knife, chopping board, stirring machine, buckets, sieves, pasteuriser, capping machine, spatulas, stove, pot, refrigerator, pipettes, pH metre, refractometer, hydrometer and alcoliser.

Sensory evaluation

The sensory evaluation was conducted in the consumer sensory insights laboratory, where a panel of 12 evaluated the samples in separate booths. Each panellist was given a tasting cup filled

with the product and a paper cup filled with water. The evaluation was based on colour, mouthfeel, texture, aroma, and overall acceptability as a cream liqueur. The responses were captured in tasting sheets that were handed out.

Determining the pH (conducted in duplicates)

The process involved calibrating a pH metre using two buffer solutions (pH = 4 and pH = 7), rinsing the electrode with distilled water, and preparing samples. The samples were collected and decarbonated using a pipette. The electrode was then measured by immersing it in two samples, reading the pH value. After the measurements, the electrode was rinsed and stored.

ABV % (conducted in duplicates)

This analysis involved calibrating the alcoliser and preparing samples by transferring them into vials. The samples were inserted into the device, and the ABV% was read. The results are displayed on the screen, and the device is cleaned to maintain accuracy for future use.

Specific gravity (conducted in duplicates)

The hydrometer preparation process involved cleaning the device to ensure that it was free of residues or contaminants and then starting the analysis. The samples were poured into two transparent cylinders, and the hydrometer was lowered into the samples. The specific gravity readings are then recorded at the hydrometer scale.

Sugar content -Brix (conducted in duplicates)

The process involved preparing a refractometer by pouring a drop of distilled water using a pipette onto the prism and wiping it off using Kim wipes, preparing a sample by decarbonating it, placing the sample on the prism using a pipette, reading the Brix percentage, and recording the results. Post-measurement, the prism was cleaned to prevent contamination for future measurements.

Results and Discussion

Sensory evaluation

Sensory evaluation was conducted to assess the sensory acceptability of the four different cream liqueur formulations. This evaluation took place in the consumer sensory insights laboratory, where a panel of 12 trained testers evaluated the samples. The evaluation focused on five key attributes: colour, mouthfeel, texture, aroma, and overall acceptability as a cream liqueur. The panellists recorded their responses on tasting sheets provided during the session.

In Trial 1, the sample had no xanthan gum, it was noted for its separation after two days, leading to a decline in sensory appeal. The panellists reported that the product had an opaque appearance and described its taste as acidic and bitter. The initial creamy texture was deemed unsustainable, as the product lacked a stabiliser. This lack of stability resulted in a less favourable overall acceptability among the panellists, who rated the product lower in terms of both texture and overall enjoyment. Trial 2 involved the addition of 0.25% xanthan gum. The product did not separate, but it exhibited a thick and slimy mouthfeel, which some panellists found was less pleasant. Despite this, the flavour balance between pear and sorghum was positive, and a light beige colour was considered appealing. Panellists rated this trial higher in terms of colour and flavour balance, although the mouthfeel impacted the overall acceptability. Trial 3 included yeast extract, condensed milk, and vanilla extract but omitted xanthan gum. Although the product separated after one week, it was described as creamy with a pleasant, fruity aroma. The flavour was well received, and the beige colour was appreciated. Panellists liked the creamy texture and aroma, but the separation over time and lack of xanthan gum led to mixed ratings regarding overall stability and texture. Trial 4 included yeast extract, condensed milk, vanilla extract, and 0.25% xanthan gum. This formulation did not separate upon storage and was noted for its pleasant creamy texture. The aroma, with hints of vanilla and alcoholic notes, was well regarded, and the product

maintained a well-balanced flavour profile. Panellists rated this trial highest in terms of all sensory attributes, including colour, mouthfeel, texture, aroma, and overall acceptability. Xanthan gum effectively stabilised the product, enhancing its overall enjoyment.

The sensory evaluation highlights the significant impact of ingredient modifications on the sensory properties of cream liqueurs. The absence of xanthan gum in Trial 1 resulted in product separation and a less favourable sensory profile, with lower ratings for texture and overall acceptability. The introduction of xanthan gum in Trial 2 improved product stability but led to a less desirable mouthfeel. In Trial 3, the addition of yeast extract, condensed milk, and vanilla extract improved flavour and aroma, but the lack of xanthan gum resulted in separation and mixed overall acceptability. Finally, Trial 4 demonstrated that the optimal combination of xanthan gum, yeast extract, condensed milk, and vanilla extract yielded the highest ratings across all attributes, providing a stable, creamy, and well-balanced cream liqueur. The panellists' evaluations indicate that the formulation used in Trial 4 offers the most favourable sensory attributes, highlighting the effectiveness of xanthan gum in enhancing product stability and overall sensory acceptability.

Figure 1: Trial 1 sample showing separation after 2 days of being stored in the refrigerator

Figure 2: Trial 2 samples after 2 days of being stored in the refrigerator

Figure 3: Trial 3 sample showing an oil-like layer separation after 2 days of being stored in the refrigerator

Figure 4: Trial 4 sample after 2 days of being stored in the refrigerator

Table 1: Quantitative analysis results obtained from the four trials

	TRIAL 1	TRIAL 2	TRIAL 3	TRIAL 4
BRIX	Sample 1 – 4.40 °Bx Sample 2 – 4.38 °Bx Average – 4.39 °Bx	Sample 1 – 6.2 °Bx Sample 2 – 6.15 °Bx	Sample 1 – 20 °Bx Sample 2 -20.01 °Bx	Sample 1 – 36.52 Sample 2 -36.50 Average –36.51
	Standard Dev - 0.01	Average –6.175 **°Bx** Standard Dev - 0.025	Average-20.005 **°Bx** Standard Dev- 0.005	Standard Dev - 0.01
pH	Sample 1 -3.612 Sample 2 -3.60 Average –3.606 Standard Dev - 0.006	Sample 1 -3.2 Sample 2 -3.1 Average –3.15 Standard Dev - 0.05	Sample 1 – 6.5 Sample 2 -6.47 Average – 6.485 Standard Dev- 0.015	Sample 1 – 6.78 Sample 2 – 6.77 Average – 6.775 Standard Dev - 0.005
ABV%	Sample 1 -10.61 Sample 2 -10.59 Average –10.60 Standard Dev -0.01	Sample 1 -10.32 Sample 2 -10.33 Average –10.325 Standard Dev - 0.005	Sample 1 -14.33 Sample 2 -14.30 Average –14.315 Standard Dev - 0.015	Sample 1 -14.67 Sample 2 -14.69 Average –14.68 Standard Dev - 0.01
SPECIFIC GRAVITY	Sample 1 -0.92 Sample 2 -0.91 Average –0.915 Standard Dev - 0.005	Sample 1 -0.94 Sample 2 – 0.96 Average –0.95 Standard Dev - 0.01	Sample 1 -0.96 Sample 2 -0.98 Average –0.97 Standard Dev - 0.01	Sample 1 -1.0 Sample 2 -0.99 Average – 0.995 Standard Dev - 0.005

The results presented in Table 1 reveal notable variations in Brix levels across the trials, reflecting an increase in the sucrose content of the formulations. This increase in Brix values, which measures the concentration of dissolved solids, suggests that more sugar was added or that there was a greater overall concentration of dissolved solids in the later trials. Additionally, the pH values recorded in the table provide insight into the acidity or basicity of the products. Trials 1 and 2, which had lower pH values, indicate that more acidic conditions are typically associated with the early stages of fermentation. In contrast, Trials 3 and 4 exhibited higher pH levels due to the inclusion of condensed milk in the formulations. Condensed milk acts as a pH buffer, helping to moderate the acidity and maintain a more stable pH (Xolo et al., 2024)

The standard deviations in the pH measurements across the trials were generally low, indicating consistent pH readings. However, Trial 2 showed a slightly greater standard deviation, which may suggest minor inconsistencies in sample conditions or measurement techniques. The ABV percentage, which indicates the alcohol content of the liqueur, demonstrated an increase from Trials 1 through 4. This increase can be attributed to variations in fermentation length, with Trial 4 undergoing the longest fermentation period. Additionally, Trials 3 and 4 involved the fermentation of prickly pear, contributing to increased alcohol production, a step not included in Trials 1 and 2. The specific gravity, which measures the density of the liquid relative to water, also varied among the trials. Higher specific gravity values in Trials 3 and 4 correspond with increased sugar or alcohol content, which aligns with the higher Brix and ABV values observed. The low standard deviations across all trials and parameters indicate a high degree of precision in both measurement and sample handling.

Conclusion

This study successfully developed a novel cream liqueur utilising sorghum and prickly pears, demonstrating the feasibility of these ingredients in cream liqueur production. The inclusion of 0.25% xanthan gum was highly effective in stabilising the cream liqueur.

This ingredient significantly enhanced the texture and prevented phase separation, contributing to a more stable and visually appealing product. Pasteurisation at 90°C for 10 minutes was confirmed to be an effective method for ensuring product safety. This process eliminates the need for additional preservatives, maintaining the natural qualities of the ingredients while ensuring the product's safety. The sensory evaluation results indicated high acceptability among the panellists, with favourable ratings for colour, mouthfeel, texture, aroma, and overall flavour profile. The liqueur's unique combination of sorghum and prickly pears was well received, suggesting strong potential for commercialisation. The successful integration of sorghum and prickly pears offers a valuable alternative to traditional cream liqueur ingredients. This innovation expands the range of suitable beverage options, providing consumers with a distinctive and novel flavour experience.

References

Adekoya, I., Obadina, A., Olorunfemi, M., Akande, O., Landschoot, S., De Saeger, S., & Njobeh, P. (2019). Occurrence of bacteria and endotoxins in fermented foods and beverages from Nigeria and South Africa. International Journal of Food Microbiology, https://doi.org/10.1016/j.ijfoodmicro.2019.108251

Agarbati, A., Canonico, L., Ciani, M., Morresi, C., Damiani, E., Bacchetti, T., & Comitini, F. (2024). Functional potential of a new plant-based fermented beverage: Benefits through non-conventional probiotic yeasts and antioxidant properties. International Journal of Food Microbiology, 424, 110857. https://doi.org/10.1016/j.ijfoodmicro.2024.110857

Apud, G. R., Kristof, I., Ledesma, S. C., Stivala, M. G., & Aredes Fernandez, P. A. (2024).

Health-promoting peptides in fermented beverages. Revista Argentina de Microbiologia. https://doi.org/10.1016/j.ram.2024.02.003

Gungor, G., Akpinar, A., & Yerlikaya, O. (2024). Production of plant-based fermented beverages using probiotic starter cultures and Propionibacterium spp. Food Bioscience, https://doi.org/10.1016/j.fbio.2024.103840

59. https://doi.org/10.1016/j.fbio.2024.103840

Hlangwani, E., Njobeh, P. B., Chinma, C. E., Oyedeji, A. B., Fasogbon, B. M., Oyeyinka, S. A., Sobowale, S. S., Dudu, O. E., Molelekoa, T. B. J., Kesa, H., Wilkin, J. D., & Adebo, O. A. (2023). African cereal-based fermented products. In Indigenous Fermented Foods for the Tropics (pp. 15–36). Elsevier. https://doi.org/10.1016/B978-0-323-98341- 9.00031-1

Ogunremi, O. R., Freimüller Leischtfeld, S., Mischler, S., & Miescher Schwenninger, S. (2022). Antifungal activity of lactic acid bacteria isolated from kunu-zaki, a cereal-based Nigerian fermented beverage. Food Bioscience, 49. https://doi.org/10.1016/j.fbio.2022.101648

Shumye Gebre, T., Admassu Emire, S., Okomo Aloo, S., Chelliah, R., Vijayalakshmi, S., & Hwan Oh, D. (2024). Unveiling the potential of African fermented cereal-based beverages: Probiotics, functional drinks, health benefits and bioactive components. In Food Research International (Vol. 191). Elsevier Ltd. https://doi.org/10.1016/j.foodres.2024.114656

Xolo, T., Keyser, Z., & A Jideani, V. (2024). Physicochemical and microbiological changes during two-stage fermentation production of umqombothi. Heliyon, 10(2). https://doi.org/10.1016/j.heliyon.2024.e24522

Yang, C. T., Kristiani, E., Leong, Y. K., & Chang, J. S. (2023). Big data and machine learning driven bioprocessing – Recent trends and critical analysis. Bioresource Technology, 372. https://doi.org/10.1016/j.biortech.2023.128625