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Standardization of Ginger Blended Cider in Molvom Cultivar Pineapple (*Ananas comosus*)

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A B S T R A C T

The study was conducted in Completely Randomized Design (CRD) with 8 treatments with three replication each. The treatments were T_1 Molvom Pineapple juice (700ml) + Sugar (200g) + Wine yeast (1.5g)+ 2.5ml Ginger extract, T_2 Molvom Pineapple juice (700ml) + Sugar (200g) + Wine yeast (1.5g)+ 5ml Ginger extract, T_3 Molvom Pineapple juice (700ml) + Sugar (200g) + Wine yeast (1.5g) + 7.5ml Ginger extract, T_4 Molvom Pineapple juice (700ml) + Sugar (200g) + Wine yeast (1.5g) + 10ml Ginger extract, T_5 Molvom Pineapple juice (700ml) + Sugar (200g) + Wine yeast (1.5g) + 12.5ml Ginger extract, T_6 Molvom Pineapple juice (700ml) + Sugar (200g) + Wine yeast (1.5g) + 15ml Ginger extract, T_7 Molvom Pineapple juice (700ml) + Sugar (200g) + Wine yeast (1.5g) + 17.5ml Ginger extract, T_8 Molvom Pineapple juice (700ml) + Sugar (200g) + Wine yeast (1.5g)+ 20ml Ginger extract. Total soluble solids, pH and Specific Gravity decreased while the alcohol content, Acidity and the Sensory Qualities increased with increasing length of fermentation. From the above treatments, it is concluded that treatment T_8 was found superior in respect of the parameters like Total Soluble Solids, Alcohol content, Specific gravity. In terms of Acidity, pH the best was found in treatment $T_{7.}$ In terms of Colour and Appearance the best was found to be treatment T_7. And in terms of Taste, Aroma and Overall acceptability was found best in T_8.Since pineapple fruit is rich in sugars, minerals, and polyphenols, hence production of wine or cider may serve as a viable method to preserve the nutritional and antioxidant properties of the fruit. The production of wine or cider from this fruit can also help increase wine and cider variety and reduce post-harvest losses. This study showed that acceptable cider can be produced from pineapple and extract of ginger using yeast especially *Saccharomyces cerevisiae*.

Introduction

Cider and wine production is an ancient practice found in many countries, with extensive research conducted on various aspects of fruit-based wine making. The character and quality of these beverages primarily depend on the fruit variety and composition. Fruit ciders, known for their delicious taste, nutrition, and delicate stimulation, are non-distilled alcoholic beverages. Wines often bear the names of the fruits from which they are made. Preferences and expectations of cider and wine consumers vary across different geographic and social contexts. For example, Asian and Western cultures exhibit distinct preferences for fruit ciders due to their diverse food choices (Lin *et al.,* 2018). The basic process of cider making involves fermenting fruit juice with *Saccharomyces cerevisiae*, a commonly used yeast, which converts sugar into ethanol.

Yeasts play a crucial role in the cider and wine industry, with *Saccharomyces cerevisiae* being the most commonly employed yeast strain during alcoholic fermentation. The selection of yeast strains is important for a complete fermentation and to enhance the final characteristics of the beverage. Yeasts can produce compounds that give a distinctive flavor and aroma to the end product (Ansari *et al.,* 2022). Pleasant and aromatic fruits are often preferred for cider making, and one such fruit is pineapple (*Ananas comosus*). Pineapple is a tropical fruit renowned for its distinctive aroma and sweet taste. It is highly regarded for its flavorful profile, as it contains a variety of volatile compounds in complex mixtures, albeit in small amounts. Pineapple is not only appreciated for its taste but also valued for its rich mineral and vitamin content, which provides numerous health benefits. In the international market, pineapple ranks third in demand, trailing only banana and citrus fruits. Consequently, the pineapple industry has experienced significant growth, both in terms of utilizing pineapple for food-based processing products and waste management on a global scale. Pineapple is a rich source of bioactive compounds, dietary fiber, minerals, and nutrients. Additionally, pineapple has demonstrated various health benefits, including anti-inflammatory and antioxidant properties, support for the nervous system, and aiding in digestion (Narendranath and Power, 2005). Belonging to the Bromeliaceae family, pineapple originated in South America. Molvom village is known for its pure organic pineapple, considered one of the finest in the region (Jangyukala and Laishram Hemanta). The production of pineapple wine not only serves as a means to extend its shelf life but also adds economic value to the fruit. Ginger has a long history of medicinal use, particularly in treating gastrointestinal disorders, owing to its chemical components. The ginger rhizome contains various bioactive elements, including gingerols, shogaols, zingiberene, zingerone, and paradol. These compounds have the potential to stimulate oral and gastric secretions, regulate gastrointestinal motility, interact with receptors such as 5HT3 and NK1 associated with the nausea reflex and vomiting (commonly experienced during chemotherapy treatment), and possess antioxidant properties (Ali, *et al.,* 2020) Cider is commercially produced through yeast fermentation, converting sugar into alcohol. It serves as a nutrient supplement, allowing access to seasonal fruits and vegetables year-round.

Utilizing fruits and vegetables with medicinal and nutritional value in cider and wine production can enhance their health benefits (Giri *et al.,* 2013). Wine, being a complex mixture, contains various chemical constituents and metabolites that synergistically impact human health. Moderate consumption of cider in healthy individuals may provide protection against certain chronic health conditions (Jha, 2010). Pineapple, with its moderate sugar and acidity levels and strong aroma, is an attractive choice for fruit cider production, offering opportunities for further processing (Ningli *et al.,* 2017).

Producing wine from pineapple not only prolongs its shelf life but also adds economic value (Clemente and Scapim, 2005). Food processing plays a crucial role in minimizing postharvest losses and establishing stronger connections between the agriculture and industry sectors. One effective approach to reducing these losses is by transforming surplus food into value-added products, including fermented and unfermented beverages. Fermentation serves as a promising method for developing new products from fruits, modifying their physiochemical and sensory properties, particularly flavor and nutritional composition (Dubey, 2002).

Materials and Methods

The study was conducted in Completely Randomized Design (CRD) with 8 treatments with three replication each. The treatments were T_1 Molvom Pineapple juice (700ml) + Sugar (200g) + Wine yeast (1.5g) + 2.5ml Ginger extract, T_2 Molvom Pineapple juice (700ml) + Sugar (200g) + Wine yeast (1.5g) + 5ml Ginger extract, T_3 Molvom Pineapple juice (700ml) + Sugar (200g) + Wine yeast (1.5g) + 7.5ml Ginger extract, T_4 Molvom Pineapple juice (700ml) + Sugar (200g) + Wine yeast (1.5g) + 10ml Ginger extract, T_5 Molvom Pineapple juice (700ml) + Sugar (200g) + Wine yeast (1.5g) + 12.5ml Ginger extract, T_6 Molvom Pineapple juice (700ml) + Sugar (200g) + Wine yeast (1.5g) + 15ml Ginger extract, T_7 Molvom Pineapple juice (700ml) + Sugar (200g) + Wine yeast (1.5g) + 17.5ml Ginger extract, T_8 Molvom Pineapple juice (700ml) + Sugar (200g) + Wine yeast (1.5g) + 20ml Ginger extract.

Fruit

Pineapples were brought from Molvom village in Chumekedima district of Nagaland on 13 August 2022 whereas the Ginger was brought from the local market at Mahewa Khan Chaurah Prayagraj and stored in the Post-Harvest Laboratory of Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj at room temperature. On 18^{th}August 2022 processing was started.

Chemicals

All the chemicals used in this Research were of analytical grade. They were obtained from the Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Naini, Prayagraj-211007 (UP).

Equipment's and Instruments

Different equipment required for the preparation of Molvom pineapple cider such as hand Refractometer, hydrometer, Digital pH meter, beaker, conical flask etc. were made available from the Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj.

Yeast (Brewer's yeast)

Dry wine yeast culture *Saccharomyces cerevisiae* was ordered online from Gut basket.

Glass Bottles

Glass bottles of 500ml was procured from Vishal Mega Mart civil lines, Prayagraj and sterilized by keeping it in boil water for 10-15min to avoid microbial contamination.

Methods of Preparation of Molvom Pineapple Cider

Sorting of fruits

The fruits were examined for rotting. Completely rotten fruits were discarded and rotten part of fruits was removed.

Preparation of ginger extract

The ginger to be extracted was thoroughly washed and peeled and was sliced into thin chunks to be grinded and thereafter the ginger extracts were extracted using muslin cloth.

Peeling and Cutting of fruit

All the selected fruits were peeled and cut into slices. A stainless-steel knife was used for the same.

Preparation of must

Riped pineapple fruits were selected and peeled, sliced and cut into pieces and pulverized using sterile Philip electric blender with the addition of water. The slurry was further diluted in a ratio of 1:1 (water and pulp) and sieved with a muslin cloth of pore size 0.8 mm to obtain the filtrate "must". Chaptalization and supplementation of the "Must". The methods of Amerine and Kunkee as used by Robinson were used. These bottled juices were cold stored till further experiments were conducted

Preparation of bottles

Bottles were washed thoroughly with hot water and kept it for sun dry and get it sterilized.

Preparation of yeast starter culture

A yeast starter culture was prepared for fermentation using a specific quantity of must, a small amount of sugar, yeast, and a known volume of water. The mixture was combined and left to stand for 24 hours. Additionally, approximately 200 ml of water was boiled and then allowed to reach a temperature of 37°C. Then, 200 ml of the Molovom pineapple must mixture, which had been treated with sugar, was added. Next, approximately 3.7 ml of yeast (*S. cerevisiae*), representing approximately 108 cfu/ml (as measured using the McFarland standard) and obtained after centrifugation, was added to the mixture. The mixture was thoroughly stirred and left to stand for 24 hours before use. Throughout the fermentation process, several parameters were monitored, including specific gravity, pH, titratable acidity, total soluble solids, and alcohol content. These parameters were assessed both before and during the fermentation process to track the progress of the fermentation and ensure the desired outcomes.

Fermentation of must

The primary fermentation process was initiated by adding the starter culture to the must. The must was stirred every 12 hours, and specific gravity, pH, temperature, and alcohol content readings were taken over a period of 4 days. After 4 days, the wine was transferred to a secondary fermenter. The secondary fermentation took place in an airtight container, with a tube inserted into a clean bottle filled with water. This setup allowed for the monitoring of the fermentation process. The secondary fermentation continued until fermentation was complete, which was indicated by the absence of bubbles in the container, typically occurring within 3 weeks. The secondary fermentation lasted for 21 days. Once fermentation stopped, the wine was carefully separated from the sediment (lees) to minimize oxygen exposure. The upper liquid was transferred to another clean container to remove impurities. The mixture was then allowed to ferment further at a temperature of 20°C for additional days. Afterward, the wine was aged for 3 months under storage conditions of 20°C.At the end of the secondary fermentation, microbial analysis, as well as measurements of alcohol content, sugar content, specific gravity, titratable acidity, and pH of the wine, were performed to assess its quality and characteristics.

Clarification of cider

Once fermentation was complete, the wine was carefully siphoned off and filtered using various sterilized materials, including muslin cloth, Whatman No.1 filter paper, sieves, and syphon tubes sterilized with 70% alcohol. The filtered wine was collected in sterile glass jars. To further clarify the wine, it underwent a racking process for a duration of 3 weeks.

During this time, any remaining residues settled to the bottom and were removed, while the clarified wine was allowed to mature. Clarification is a crucial step in wine production since fermented wine typically contains sediments that need to be eliminated for a clear and visually appealing final product. After the clarification process, the wine was ready for other chemical analyses and assessments.

Aging

After cider production, aging plays a crucial role in improving wine quality. Once the cider has matured, the clear liquid is transferred to fresh sterile bottles, corked, and subjected to pasteurization at 82ºC for 20 minutes. After cooling, the cider is aged in 750 ml bottles for 17 days at 22-25ºC before analysis

(Chowdhury and Ray, 2007). Physiochemical properties are assessed at 30-day intervals, starting from 30 days after fermentation. Organoleptic evaluation by a panel of judges determines consumer acceptance.

Packaging and preservation

For the storage and marketing of mature cider, it is important to use clean containers that are suitable for packaging. Glass bottles are highly recommended due to their ease of cleaning and sterilization. The bottles used for packaging should undergo sterilization to significantly reduce the microbial load. Glass is the traditional and preferred packaging material for cider due to its inertness and clarity, allowing consumers to appreciate the color and clarity of the cider.

Storage

Proper storage is crucial for cider, whether it's aged for long-term maturation or prepared for immediate consumption. Fresh cider needs to be aged until it becomes drinkable and marketable, and the evolution of flavours during this aging process is essential. Cider, like wine, can improve with age but can also deteriorate rapidly under unfavourable conditions. Several factors influence the composition and quality of cider during storage. Parameters such as temperature, illumination, bottle position, oxygen content, and storage time play a role in the continuous changes that occur.

These changes are complex and can affect aroma, color, and phenolic composition. Creating favorable conditions during aging is important. Temperature, humidity, and light exposure all contribute to significant modifications in the cider's organoleptic characteristics, leading to improved flavors. High temperatures accelerate reactions among components, often causing undesirable changes, while low temperatures slow down the aging process and can result in more desirable flavors and tastes. Cider bottles can be stored for over six months at temperatures between 10°C and 25°C. It is important for the bottles to be airtight to prevent the effects of humidity. Dry places are suitable for longer storage of cider bottles.

Physico-chemical and Organoleptic Characteristics

During the preparation and storage of the cider under room conditions, various physico-chemical changes were monitored. The following parameters were tested:

pH: The pH of the cider was measured using a digital pH meter.

Total Soluble Solids (TSS): The TSS, which represents the sugar content, was determined using a hand refractometer.

Titratable Acidity: The titratable acidity of the cider was measured using a titrimetric method.

Alcohol Content: The alcohol content of the cider was determined using a hydrometer.

Specific Gravity: The specific gravity of the cider was also measured using a hydrometer.

Additionally, the sensory evaluation of the cider was conducted. The cider was evaluated for color, flavor, aroma, and overall acceptability by a panel of judges to assess its sensory attributes and consumer preference.

Total Soluble Solids (TSS)

During storage, there was a consistent decrease in the Total Soluble Solids (TSS) content of Molvom pineapple cider with different levels of yeast and sugar. This decrease can be attributed to the fermentation process, where the yeast converts sugars into alcohol. Among the different treatment groups, the lowest TSS score was observed in treatment T8, followed by treatment T7, while the maximum score was observed in treatment T5 throughout the storage period.

Table.1 Physico-chemical properties of different levels of concentration of ginger concentrate on the production of pineapple cider

Treatment	Treatment combination	T.S.S(°BRIX)				Alcohol Content (%)			Titratable Acidity (%)				pH				Specific gravity			
		Initial	30 Days	60 Days	90 Days	30 Days	60 Days	90 Days	Initial	30 Days	60 Days	90 Days	Initial	30 Days	60 Days	90 Days	Initial	30 Days	60 Days	90 Days
T1	Molvom pineapple cider + 2.5ml ginger extract	17.8	14.35	10.11	7.34	2.88	4.06	9.46	0.32	0.58	0.66	0.69	5.83	4.66	3.95	3.7	1.075	1.054	1.045	1.003
T2	Molvom pineapple cider +5ml ginger extract	17.86	14.37	10.24	7.3	2.75	4.06	9.56	0.31	0.53	0.63	0.7	5.73	4.83	4.13	3.84	1.078	1.056	1.047	1.006
T3	Molvom pineapple cider + 7.5ml ginger extract	17.93	14.44	10.35	7.4	2.84	3.83	9.57	0.32	0.44	0.58	0.72	5.81	4.67	3.92	3.76	1.076	1.057	1.048	1.003
T4	Molvom pineapple cider + 10ml ginger extract	17.96	14.53	10.45	7.44	1.85	3.95	8.8	0.33	0.58	0.67	0.72	5.74	4.84	4.11	3.92	1.074	1.06	1.043	1.007
T5	Molvom pineapple cider + 12.5ml ginger extract	18.61	14.63	10.52	7.46	2.23	4.33	9.72	0.32	0.58	0.67	0.75	5.83	4.63	3.86	3.71	1.077	1.062	1.045	1.005
T6	Molvom pineapple cider + 15ml ginger extract	18.34	14.82	10.46	7.37	2.64	5.25	10.35	0.33	0.55	0.61	0.7	5.8	4.68	3.83	3.75	1.08	1.062	1.041	1.001
T7	Molvom pineapple cider + 17.5ml ginger extract	18.42	14.93	10.35	7.27	2.77	5.53	11.15	0.34	0.59	0.7	0.78	5.85	4.73	3.71	3.68	1.084	1.063	1.043	0.999
T8	Molvom pineapple cider + 20 ml ginger extract	18.64	15.17	10.32	7.23	2.52	5.93	11.49	0.36	0.56	0.65	0.72	5.82	4.89	4.12	3.85	1.084	1.066	1.039	0.996
F-Test		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
SE(d)		0.124	0.09	0.11	0.15	0.01	0.014	0.02	0.01	0.009	0.007	0.01	0.01	0.12	0.009	0.007	0.001	0.001	0.001	0.001
C.D at 0.5%		0.265	0.192	0.023	0.031	0.021	0.029	0.042	0.02	0.019	0.016	0.021	0.022	0.026	0.019	0.016	0.002	0.002	0.002	0.002

Fig.1 Effect of different levels of Ginger extract on T.S.S of pineapple cider from Molvom cultivar

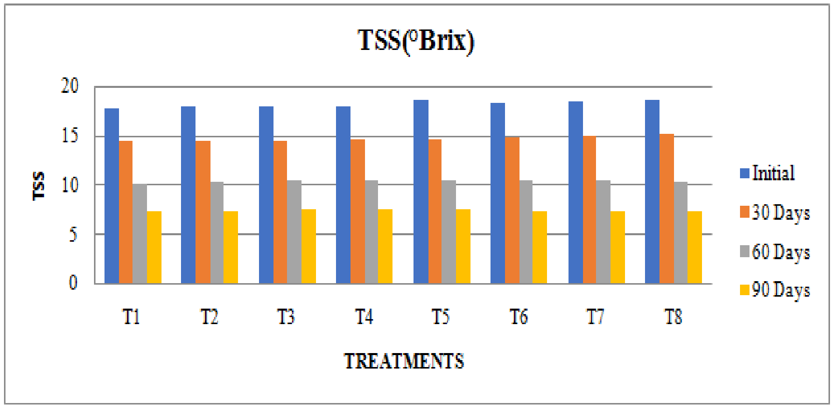

Fig.2 Effect of different levels of Ginger extract on Alcohol percentage of pineapple cider from Molvom cultivar

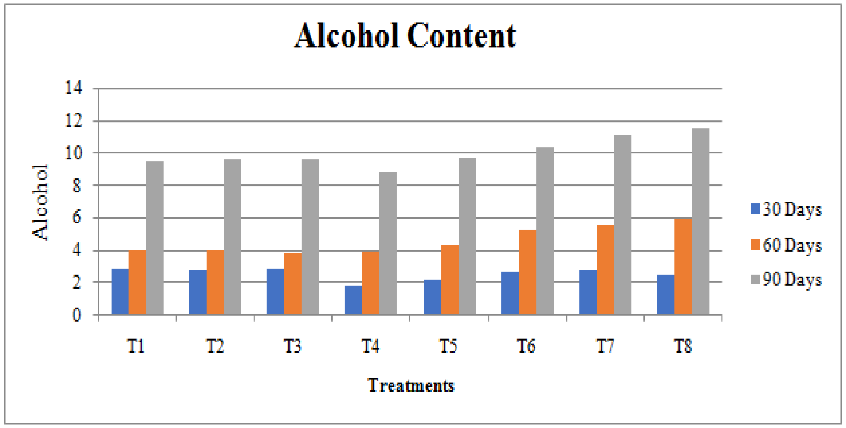

Fig.3 Effect of different levels of Ginger extract on Titratable Acidity of pineapple cider from Molvom cultivar

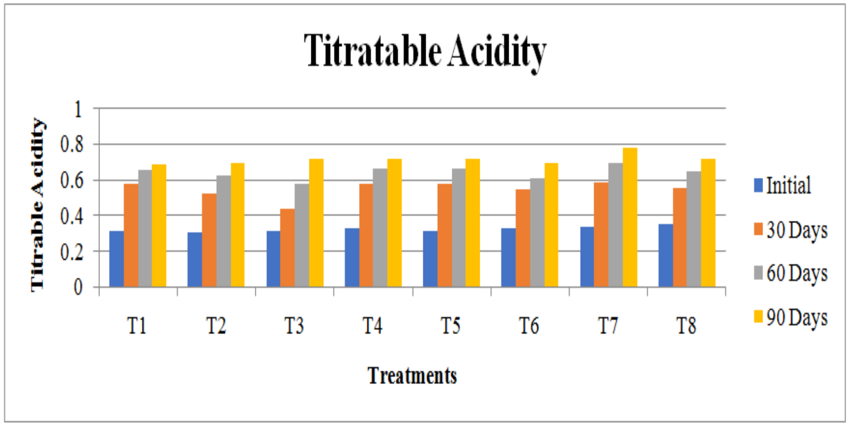

Fig.4 Effect of different levels of Ginger extract on pH of pineapple cider from Molvom cultivar

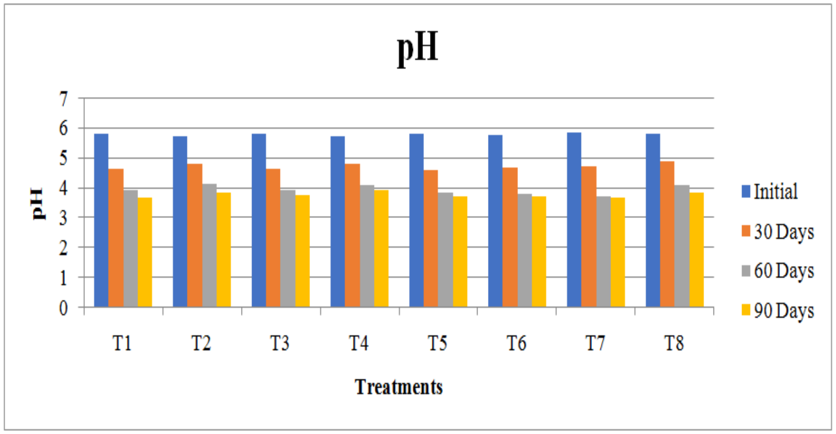

Fig.5 Effect of different levels of Ginger extract on Specific Gravity of pineapple cider from Molvom cultivar

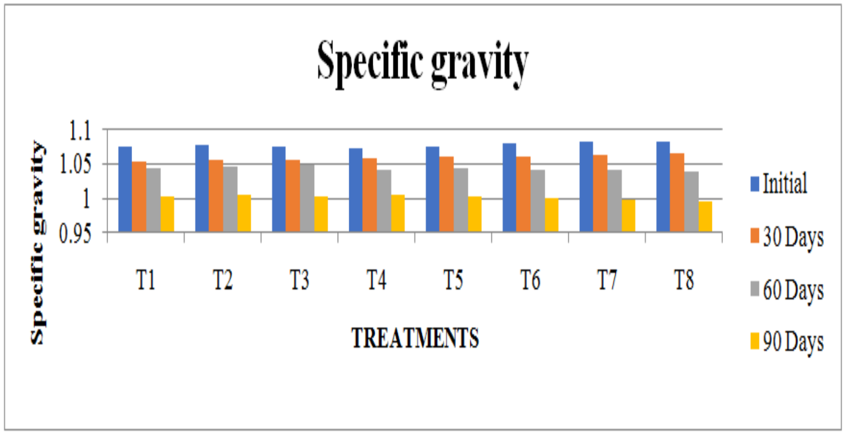

Fig.6 Organoleptic score for Overall Acceptability of Pineapple cider during storage

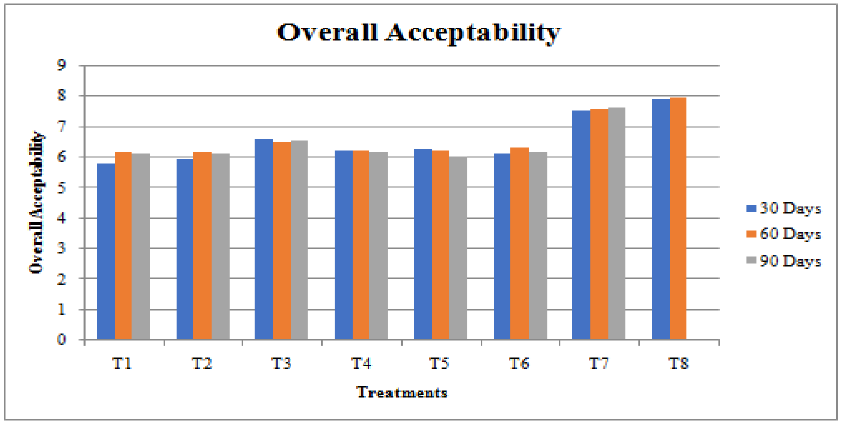

Table.2 Variation in Overall Acceptability due to different levels of ginger extract on pineapple cider from Molvom cultivar

Treatment	Treatment combination	Overall Acceptability		
		30 Days	60 Days	90 Days
T1	Molvom pineapple cider + 2.5ml ginger extract	5.79	6.20	6.14
T2	Molvom pineapple cider +5ml ginger extract	5.97	6.18	6.15
T3	Molvom pineapple cider + 7.5ml ginger extract	6.61	6.50	6.58
T4	Molvom pineapple cider + 10ml ginger extract	6.22	6.23	6.20
T5	Molvom pineapple cider + 12.5ml ginger extract	6.26	6.23	6.03
T6	Molvom pineapple cider + 15ml ginger extract	6.14	6.31	6.20
T7	Molvom pineapple cider + 17.5ml ginger extract	7.56	7.58	7.63
T8	Molvom pineapple cider + 20 ml ginger extract	7.91	7.98	8.12
F-Test		S	S	S
SE(d)		0.387	0.388	0.413
C.D at 0.5%		0.828	0.829	0.883

The decrease in TSS content indicates the utilization of sugar present in the cider during fermentation. These findings align with the results of previous studies conducted on pineapple wine by Thunbeni *et al.,* (2020); Idise *et al.,* (2010) in pineapple wine.

Alcohol content

The ethanol content in cider is a crucial parameter that plays a significant role in its stability, ageing, and sensory properties. Ethanol acts as a preservative, aids in dissolving volatile compounds, and influences the production of aromatic compounds, thus impacting the overall quality of the cider. During storage, the alcohol content of Molvom pineapple cider with different levels of yeast and sugar showed significant differences among all the treatments. As the fermentation time increased, the concentration of alcohol also increased. Treatment T8 had the highest score for alcohol content, followed by treatment T7, while treatment T1 had the lowest score. The observed trend of increasing alcohol content and decreasing TSS during fermentation is consistent with the typical fermentation behavior observed in fruit-based wine or cider production. The variations in yeast performance in utilizing fermentable sugars can influence fermentability and, consequently, the production of alcohol in pineapple cider (Joshi and Attri, 2005). These findings are in line with the research by Amerine and Ough (1982) that highlights the impact of yeast performance on alcohol production in fermented beverages.

Titratable Acidity (%)

Acidity is a critical factor in determining the quality of cider as it influences the fermentation process and contributes to the overall balance and characteristics of the beverage. Insufficient acidity can result in poor fermentation, while appropriate acidity is important for wine quality (Clarke and Bakker, 2004). The acidity (%), evaluated in Molvom pineapple cider with different levels of yeast and sugar during storage, showed significant differences among all the treatments. There was a subsequent increase in acidity at different periods of storage. Treatment T7 had the highest score for acidity, followed by treatment T5, while treatment T1 had the minimum score. The acidity of pineapple cider exhibited an increasing trend during storage. The increase in total acidity (TA) was accompanied by a decrease in pH. This rise in acidity can be attributed to the increased alcohol production resulting from the high initial sugar concentration (Attri, *et al.*, 2017). Studies on cocoa beans fermentation by *S. cerevisiae* reported the production of various organic acids, including citric, malic, lactic, tartaric, oxalic, and succinic acids. Similar observations of increased titratable acidity during fermentation have been reported in kiwi wine. These findings align with the results of studies on banana wine and pineapple wine (Thungbeni *et al.,* 2020).Acidity plays a role in inhibiting the growth of spoilage bacteria and promoting the activity of yeast. However, excessive acidity can result in tartness, while inadequate acidity can lead to a stale and insipid taste. It's worth noting that the effect of inoculum level on total acidity may vary, as observed by (Sonar *et al.,* 2004), who reported no significant impact of inoculum level on the total acidity of fermenting juice.

pH

The pH of Molvom pineapple cider with different levels of yeast and sugar during storage showed significant differences among all the treatments. There was a subsequent decrease in pH at different periods of storage. Treatment T7 had the lowest pH score, followed by treatment T8, while treatment T4 had the highest score. The pH gradually decreased as the fermentation time increased. This variation in pH can be attributed to the different yeast strains used and the duration of fermentation. Research has indicated that low pH inhibits the growth of spoilage organisms while creating a favorable environment for desirable organisms. Additionally, low pH and high acidity provide fermentation yeast with a competitive advantage in natural environments. The decrease in pH observed in relation to the increase in acidity of the cider may be attributed to the dissociation of acid compounds and the release of hydrogen ions. Similar results have been reported in studies on mango fruit wine, mixed fruit wine (Agbor *et al.*, 2011), and pineapple wine (Ningli Qi, 2017).The pH of the cider is influenced by the composition of the must, including the presence of organic acids and sugars. These factors contribute to the overall acidity and pH of the final product.

Specific gravity

The Specific gravity of the cider with different levels of yeast and sugar during storage showed significant differences among all the treatments. There was a subsequent decrease in Specific gravity at different periods of storage. Treatment T8 had the lowest Specific gravity score, followed by treatment T7, while treatment T4 had the highest score. The Specific gravity of the cider exhibited a decreasing trend during storage. The decrease in Specific gravity can be attributed to the type of yeast used in the cider production. *Saccharomyces cerevisiae*, a common yeast strain used in fermentation, has been reported to reduce the specific gravity of fruit wines during the fermentation process. Similar findings have been reported in studies on fruit wines, including pineapple wine (Thungbeni *et al.*, 2020), general wine literature and other fruit wine studies (Okafor, *et al.*, 2018). These results suggest that the type of yeast used can influence the Specific gravity and overall quality of the cider during fermentation and storage.

Organoleptic Evaluation

In the sensory evaluation, the overall acceptability of different treatments was assessed based on sensory scores for color and appearance, taste, and aroma. The highest overall acceptability score of 7.63 was recorded for Treatment T8, which consisted of Molvom Pineapple juice (700ml), Sugar (200g), Wine yeast (1.5g), and 20ml Ginger extract. This treatment received the highest scores across all organoleptic attributes, indicating that it was well-received by the judges (as shown in Table 2).

Based on the results obtained from this experiment, it can be concluded that treatment T8, which involved the addition of 20 ml Ginger extract to the Pineapple Cider, exhibited superior qualities in terms of parameters such as Alcohol content, TSS, Specific gravity, and Colour and appearance. On the other hand, treatment T7, which included the addition of 17.5 ml Ginger extract to the Pineapple Cider, was found to be superior in terms of pH and Titratable acidity.

In terms of organoleptic parameters such as taste, aroma, and overall acceptability, treatment T8 received the highest ratings. Therefore, it can be recommended that Molvom pineapple cider blended with 20 ml of Ginger extract from treatment T8 is suitable for commercial production due to its favorable sensory characteristics and overall quality.

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