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Effect of Salt Concentration on the Preparation and Quality of Lemon Pickle (Nimki)

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Abstract

The main aim was to study the effect of dry salting (0, 5, 10, 15, and 20% by weight) on the quality of lemon pickle. The samples were analyzed for microbial profile (Yeast, mold) and chemical characteristics at 15 days intervals till 90 days and the organoleptic quality of the product was evaluated after 90 days of storage. The data were statistically analyzed using two-way ANOVA (no blocking) at a 5% level of significance results showed that titratable acidity decreased with storage time till 60 days and remained constant thereafter at all levels of salt concentrations; Vitamin C remained fairly constant at all levels of salt concentrations over the storage periods whereas it decreased steadily during storage in the control sample (i.e. 0%); Mold count was nil at 15 days for all the level of salt except control and 5% concentration and Yeast count increased with storage time regardless of the salt% used in a lemon pickle. The optimized salt concentration for the preservation of lemon was found to be 15% salt which was the best product through sensory evaluation with the least microbial load and having appreciable sensory attributes and good vitamin C retention.

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1. Introduction

Pickling—using food additives, i.e., highly concentrated salt and solution; is a well-known method for preserving foods including vegetables that has been used for thousands of years and remains in use today. Undoubtedly, the most unambiguous role of pickling for human nutrition is to make the nutrients naturally present in the original food materials more palatable while also preserving their quality (McFeeters, 1988). A pickling process is an ancient form that helps in the effective preservation and restoration of natural bioactive compounds and antioxidant capacities of fruits and vegetables (Sayin & Alkan, 2015). The juice of the lemon (*Citrus limon*) is rich in vitamin C and contains smaller amounts of B vitamin (B_1, B_2, and niacin) (Helali et al., 2008). Pickling is an affordable and practical method of preserving lemons for longer use during the off-season and is a condiment also known as "country lemon" and leems. Diced, quartered, halved, or whole, lemons are pickled in a brine solution and dry salt; occasionally spices are included as well. The pickle is allowed to ferment at room temperature for weeks or months before it is used. The flavor is mildly tart but intensely lemony makes it antibacterial. In India, the lemon is used in Indian traditional medicines Siddha Medicine and Ayurveda (Mohanapriya et al., 2013).

Foods with low pH values usually are not spoiled by bacteria but are spoilt by yeast and molds. Food with high acidity would therefore tend to be more stable microbiologically than neutral food. Salt increases osmotic pressure and hence causes plasmolysis of cells. The percentage of salt necessary to inhibit microbial growth or harm the cell varies with the type of microorganism and salt dehydrates food by drawing out water and tying up moisture as it dehydrates microbial cells and it ionizes to yield the chlorine ion, which is harmful to the organism (Frazier and Westhoff, 2002). Salt has been known to improve the palatability and acceptability of food. Sodium chloride even reduces the sourness of acids (Kalia and Sood, 1996). Dhingra et al., (2008) reviewed that osmotic dehydration of fruits and vegetables has the potential to extend their shelf life.

The objectives of this study were to identify the concentration of salt and its effect on the preservation of lemon would affect the physicochemical, microbiological, and organoleptic qualities of pickles during storage. This helps to preserve lemon as a pickle for the long term with its chemical parameters like acidity and vitamin C.

Thus, this work will prove to be beneficial to those producers who need a scientifically effective but technically simple and less costly method, to commercialize the production of lemon pickles.

2. Materials and Method

Lemon was brought from the Inaruwa market situated in the eastern part of Nepal. The fresh bright yellow was brought to Sunsari Technical College laboratory by loosely packing in polyethylene bags. Common salt used was purchased from Nepal Salt Trading Corporation. The flow chart for the optimization of the salt concentration to get the best quality lemon pickle is shown in Figure 1.

Fresh lemon

↓

Scrubbing the surface layer of lemon (to reduce bitterness)

↓

Washing in tap water and aeration for a while

↓

Raw material analysis (acidity and Vitamin C)

↓

Dry salting (0, 5, 10, 15, and 20% by weight)

↓

Analysis at 15 days interval till 90 days

[microbial load (mold, yeast) and chemical analysis (titrable acidity, vitamin C)]

↓

organoleptic properties of lemon pickle were done after 90 days

Figure 1: Flow chart of optimization of salt concentration for the preservation of lemon

2.1 Analytical procedures

Titrable acidity and Sensory evaluation of lemon pickle were determined as per Ranganna (1986). Mold count as per Aneja (2005). The experimental data were analyzed using Two-Ways ANOVA with no blocking and with replication using Genstat Discovery Edition. The difference between the data was compared using Least Significance Difference (LSD) method at a 5% level of confidence.

3. Results and Discussion

3.1 Physical and Chemical composition of fresh lemon

The average diameter of the lemon was 2.3 cm and the average weight of the lemon was found to be 34.3 g. The chemical composition of fresh lemon is presented in Table 1.

Table 1: Chemical composition of fresh lemon

Components	Values (wet basis)
Titrable acidity	5.07(0.005)
Ascorbic acid (vitamin C)	35.34(0.057)

**values are means of triplicate determinations; figures in the parentheses are the standard deviation.*

In the present study, the fresh lemon had lower (5.07%) titratable acidity than that was reported by Sindhu and khatkar (2018). Ascorbic acid content was 35.34 mg/100ml lower than that stated by Bansal and Dhawan (1993) i.e. 46.60 mg/100ml. Minor differences in the results of this study might be due to the differences in equipment used, methods, and differences in environmental conditions in which the crop was cultivated (Sindhu and khatkar, 2018).

3.2 Chemical analysis

3.2.1 Titrable acidity

Citrus foods have citric acid as the dominant acid. Increasing acidity decreases the pH but the relationship is not truly linear in the case of acidity in foods because organic acids show weak dissociation.

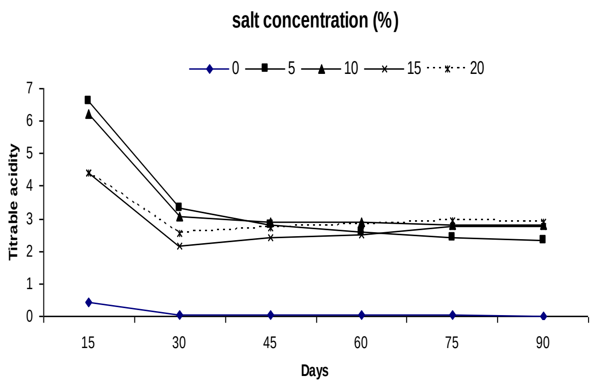

Figure 2: Changes on Titrable acidity of a lemon pickle during storage

Over the storage period (90 days), the final acidity for 0, 5, 10, 15, and 20 salt added products were

0.009±0, 2.323±0, 2.814±0, 2.744±0, and 2.899±0 % respectively as shown in figure 2. From ANOVA it was found that there was a significant effect ($p \leq 0.05$) from the 15th day to the 30th day on the entire salt %, whereas no significant difference was found after the 30th day for 5% and 10% salt concentration. On the 15th day, the sample of 5% and 10% salt concentrations sustained the natural titrable acidity of the fresh lemon, and then the titrable acidity decreased as shown in figure 2. At salt concentrations, 0%, 5%, and 10% the acidity was decreased as the day increased on the experimental days. At 20% and 15% salt concentration the acidity decreased from its initial value on the 30th day but after onward acidity slightly increased till 90 days. As the salt concentration increased from 0% to 5% the acidity of the sample also increased, but after 5% the readings remained constant on the experimental days. Reduction in acidity in citrus juice could be attributed to chemical interaction between organic constituents of juice induced by temperature and action of enzymes during storage (Sindhu and khatkar, 2018).

3.2.2 Vitamin C content

L-ascorbic acid is a water-soluble vitamin. It is present in nearly all fruits and vegetables. It is synthesized by all higher plants. Certain molds are known to synthesize this vitamin. Among animals guinea pigs, primates, and man are unable to synthesize this vitamin. In humans, this inability is due to the lack of L-gulano oxidase, an enzyme needed for the synthesis of this vitamin. The amount of vitamin C in some common fruits and vegetables (in mg/100ml) is *amala* 600, lemon 39, orange juice 64, tomato 29, and cabbage 55 (Dhingra et. al., 2008).

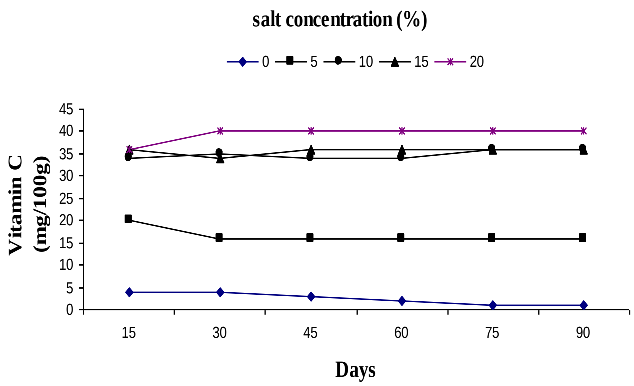

Figure 3: Changes in Vitamin C of a lemon pickle during storage

Over the storage period (90 days) the vitamin C of the sample was increased as the salt concentration was increased. At the final preservation time (90 days), the final vitamin C of the sample for 0%, 5%, 10%, 15%, and 20% were 1±0, 16±0.05, 36±0.015, 36±0.05, and 40±0.025 respectively as shown in figure 3. There was a gradual decline of vitamin C on 5% salt concentration and Vitamin C was highly reduced in the 0% sample. From ANOVA, it was found that there was a significant effect ($p \leq 0.05$) at 0% and 5% salt concentration on the 15th day whereas no significant difference was found on the rest of the sample. At salt concentration (15%), the final vitamin C of the sample for 15, 30, 45, 60, 75, and 90 were 36±0.05, 34±0.017, 36±0.07, 36±0.02, 36±0.057, and 36±0.011 respectively. At salt concentration (20%), the final vitamin C of the sample for 15, 30, 45, 60, 75, and 90 were 36±0.01, 40±0.05, 40±0.025, 40±0.02, 40±0.057, and 40±0.015 respectively. After 45 days for the entire sample, there were no significant changes in the Vitamin C content. There was good retention of vitamin C in samples 10%, 15%, and 20% salt concentration in all the experimental days, this shows that the addition of salt preserve the vitamin C over the storage days. The apparent increase in Vitamin C in the product could be due to greater loss of water to that of solute uptake.

In a study, Sulfites and metabisulfites of sodium or potassium are added to fruit juices as potential sources of sulfur dioxide, which acts as an antimicrobial agent and also stabilizes ascorbic acid. A study showed that sodium-benzoate with different concentrations on orange juice results revealed that fresh orange juice with sodium benzoate without the additions of sugar could be useable for up to 30 days (Shahnawaz et al., 2013). In another study, retention of ascorbic acid content in lemon juice (*Citrus limon*) was the highest in samples preserved with potassium metabisulphite during 90 days of storage and untreated lemon juice cannot be stored for more than a week at room temperature (Sindhu and khatkar, 2018). In salt concentrations, 10%, 15%, and 20%, the vitamin C of the sample was increased as the preservation time increased by 15 days. But at 0% and 5% salt concentration, the vitamin C content of the sample decreased every 15 days interval. From ANOVA it was found that there was a significant effect ($p \leq 0.05$) at 20% salt concentration on every experimental day. At 10%, 15%, and 20% there was good retention of vitamin C and found to be the highest.

3.3 Microbial analysis

The microbial analysis was done for yeast and mold count.

3.3.1 Mold count

The large and diverse group of microscopic foodborne yeasts and molds (fungi) includes several hundred species. The ability of these organisms to attack many foods is due to enlarging part to their relatively versatile environmental requirements. Although the majority of yeast and molds are obligate aerobes (which require free oxygen for growth), their acid/alkaline requirement for growth is quite broad, ranging from pH 2 to above pH 9. Their temperature range (10-35^0c) is also broad, with a few species capable of growth below or above this range. Moisture requirements of foodborne molds are relatively low; most species can grow at a water activity of 0.85 or less, although yeast generally requires a higher water activity.

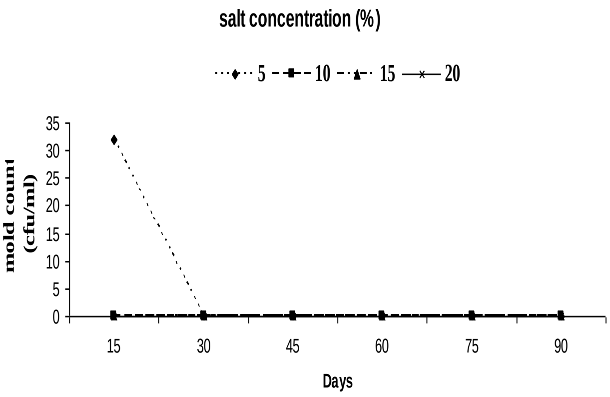

Figure 4: Changes on Mold count of a lemon pickle during storage

At preservation times 15, 30, 45, 60, 75, and 90 the mold count for each sample goes on decreased as the salt concentration increased as shown in figure 4. At 0% salt concentration there was the highest mold growth which was too many to count (TMTC) and it was not included in the graph. On the 15^{th} day for 5% salt concentration, there was high mold growth and decreased after the 15^{th} day and no mold growth was observed after 30 days onward; at 15 days of interval. But for salt concentrations, 10%, 15%, and 20% no growth of mold was observed in 15, 30, 45, 60, 75, and 90 days of preservation. From ANOVA it was found that there was a significant effect ($p \leq 0.05$) between the samples.

3.3.2 Yeast count

For the storage period (for 90 days), yeast count decreased as the salt concentration increased for every 15 days interval of time as shown in figure 5. Control sample (i.e. 0% salt concentration) data was not included in the sample as it was too many to count (TMTC). For salt concentration, 0%, 5%, 10%, 15%, and 20%; yeast count increased as the preservation time increased for every 15 days of the interval of time.

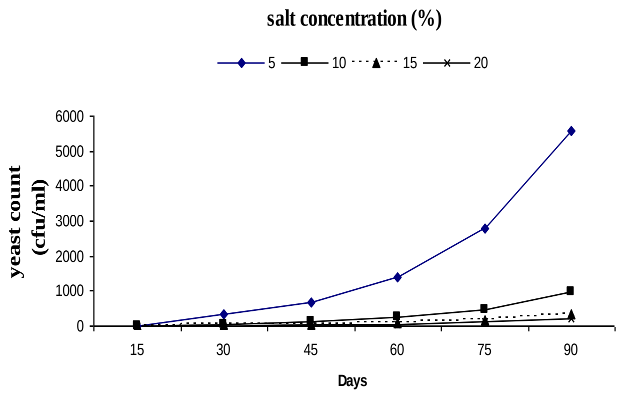

Figure 5: Changes on yeast count of a lemon pickle during storage

At the final salt concentration (20%), the final yeast count for 15, 30, 45, 60, 75, and 90 days were 0, 14±0.577, 28±0.577, 56±0.577, 112±0.577, and 224±0.577 respectively. At the final preservation time (90 days), yeast count 5%, 10%, 15%, and 20% were 5568±0.577, 960±0.577, 352±0.577, and 224±0.577 respectively which was the lowest among the sample. From ANOVA it was found that there was a significant effect ($p \leq 0.05$) between the sample and for 5% salt concentration after the 60^{th} day.

3.4 Effect of salt on sensory characteristics of lemon pickle

Finally, after 90 days of preservation sensory parameters were evaluated and the result obtained is as follows. Here sensory evaluation was performed only with four samples as shown in figure 6. The control sample i.e. 0% salt was rejected as the sample was contaminated with mold and yeast. The color score was found to be for samples A (5%), B (10%), C (15%), and D (20%) are 4, 5.6, 8, and 7.5 respectively. Statistical analysis showed that salt content had a significant ($p \leq 0.05$) effect on the color preference of lemon pickles. LSD indicated that the highest color score 8 was for lemon pickle prepared by using 15% dry salt of all the salt concentrations studied followed by sample

D. The texture score were found to be for sample A (5%), B (10%), C (15%) and D (20%) are 3.5, 6.2, 8 and 7.4 respectively. The flavor score was found to be for samples A (5%), B (10%), C (15%), and D (20%) are 3, 5.4, 7.5, and 6.8 respectively. The overall acceptability score was found to be for samples A (5%), B (10%), C (15%), and D (20%) are 3, 5.6, 8.2, and 7 respectively.

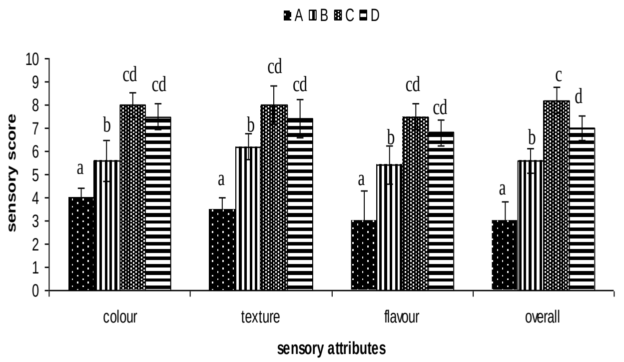

Figure 6: Average sensory score of the different parameters of lemon pickle

Finally on analyzing the overall acceptability, as seen in Figure 6, sample C (15% dry salt) has the highest mean score. This is due to the proper combination of salt thus enhancing the sensory appeal. The addition of salt in dry or in brine form is known to improve the flavor and acceptability of many foods including fruits and vegetables. Sodium chloride even reduces the sourness of acids (Kalia and Sood, 1996). Sample A had the least mean score because of the mold growth which resulted in lemons with inappreciable flavor, texture, color, and also due to less concentration of salt the consumer appeal is not much in comparison to other samples, it was performed visual only. On treating statistically it is found that the salt concentration significantly affects the color, texture, flavor, and overall acceptability at a 5% level of significance. Thus considering overall acceptability samples C (15% salt) was superior.

4. Conclusion

Lemon contained an appreciable level of ascorbic acid. The chemical properties of lemon pickles were considerably affected by different salt concentrations and storage periods. The data showed that titratable acidity decreased with storage time till 60 days and remained constant thereafter at all levels of salt concentrations; Vitamin C remained fairly constant at all levels of salt concentrations over the storage periods whereas it decreased steadily during storage in the control sample (i.e. 0%). During the storage period, the addition of salt more than 10% help to control mold growth as it was observed at 0% and 5% salt. and Yeast count increased with storage time regardless of the salt% used in a lemon pickle. The result showed that 15% dry salt for the preservation of lemon was found to be the best product; this optimization was based on microbial load reduction and sensory attributes for consumer appeal.

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Conflicts of Interest

The authors report no conflicts of interest for this work.

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