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# Study on the thermal processing of moringa leaves (*Moringa oleifera*) chicken curry

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**Abstract**
Studies were conducted to analyze the characteristics of thermally processed Moringa leaves Chicken Curry in tin cans. Product standardization was done by traditional method i.e. preparing gravy i.e. Garlic, onion, moringa leaves and chicken to make shelf stable Moringa leaves Chicken Curry. The product made was filled in pre-sterilized tin cans and sealed hermetically. After that product was thermally treated at different time and temperature combinations viz., 110°C,115°C and 120°C for 10, 15 and 20 minutes respectively in order to interpret the effects of thermal processing. Samples were evaluated initially and after that at regular intervals of 0, 20, 40, 60 days for chemical, microbiological, sensory studies and statistical analysis during storage. These studies were conducted after every 20 days interval up to other 60 days in order to depict the shelf life study due to heat treatments. It was found that the thermal processing of Moringa leaves Chicken Curry done at 120°C for 10 minutes had adequate fat percentage while as adequate protein content was found in samples processed at 110°C for 10 minutes. Moringa leaves Chicken Curry.

**Keywords:** thermal processing, shelf-life, canning, hermetic seal

## 1. Introduction
Moringa (*Moringa oleifera*) is one of the most powerful health-enhancing plants. Moringa leaf is best known as an excellent source of nutrition and natural energy booster. This energy boost is not based on sugar, and so it is sustained. Some reports have documented losses of nutrients from vegetables during drying **(**Yadav and Sehgal, 1997) [12] and cooking (Kachik *et al*., 1992; Kidmose *et al*., 2006) [5, 7]. While the continued use of Moringa (*Moringa oleifera*) for food and medicinal purposes by cultures in separate and distant parts of the world attest to its beneficial effects, Moringa is a recent "discovery" of modern science. The leaves of Moringa are nature's multi-vitamin providing 7 x the vitamin C of oranges, 4 x the calcium of milk, 4 x the vitamin A of carrots, 3 x the potassium of bananas, and 2 x the protein of yogurt. Eating 100 grams fresh Moringa leaves provides with as much protein as an egg, as much calcium as a big glass of milk, as much iron as a 200 grams beef steak, as much vitamin A as a carrot and as much vitamin C as an orange., 100 grams of fresh Moringa leaves (*Moringa oleifera*) could cover 100% of the vitamin C requirements, for which the recommended daily intake varies from 60 mg (young children) but this vitamin degrades quickly with time and during cooking and lots of health benefits. One such plant vegetable in Ghana is (*Moringa oleifera*). The basis for drying is to reduce the moisture content to a level which prolongs shelf life during storage and reduces colonization by microorganisms (Eklou *et al*. 1999) [2]. Focus group are the most commonly used form of qualitative research. They are a source of information regarding consumer attitudes, perceptions, behaviors, habits and actual practices. An illustration of this market is the wide range of options for processed meat, as represented by sausages and bologna sausages (Arora and Kempkes 2008; Pearson and Gillett 1996) [1, 10].
They are a reliable method for predicting over all trends of feeling among consumers and a valuable tool for determination of consumers" Definition of product quality (Galvez and Resurreccion 1992) [3].
Chicken (Gallus gallus) is one of the best non-vegetarian sources of protein. It is lean meat, which means that it contains more amount of proteins and less amount of fat. A 100g serving of roasted chicken (Gallus gallus) offers you 31g of protein, making it great for those who want to bulk up and build muscles. Chicken has two nutrients that are great for reducing stress tryptophan and Vitamin B5. Both of them have a calming effect on your body and this makes chicken an excellent option after a stressful day. Chicken, being rich in vitamin B6, plays an important role in preventing heart attack. Chicken (Gallus gallus) is a carbohydrate-free food. According to Nutrition Data, skinless chicken breast provides the least amount of calories and fat, about 143 calories, 3g total fat and 1g saturated fat for half of a large boneless, skinless breast, or a 95g serving. Dark meat is higher in fat. About 86g of dark meat without skin provides 165 calories and 8g total fat, 2g of which are saturated. This nutrition information is for chicken that has been stewed without added fat.

## 2. Materials and Methods
### 2.1 Procurement of raw materials
**Ingredients**
Moringa Leaves Moringawas procured from the local market Naini, Prayagraj, Chicken Chicken was procured from the local market Naini, Prayagraj, Vegetable Onions, garlic, ginger, coriander leaves will procured from the local market and care should be taken to select fresh Moringa leaves and chicken without any defect on visual inspection, Refined oil Refined oil was procured from local market, Salt: Apart from saltiness, salt attributes to flavor, texture and aids in preservation. Salt was procured from the local market, Dry spices these include cloves, cardamom, cinnamon, bay leaves, chilli powder, turmeric powder, coriander powder and was procured from the local market.

### 2.2 Equipment used
The list of various equipment used during entire work are as follows:

#### 2.2.1 Tin Cans
The cans that were used in canning process were purchased from tin cans manufacturing company namely Haslala factories private Ltd., Kashmir. The main body of the cans was flattened along with its two plates i.e. base and the lid.

### 2.3 Chemicals Used
Petroleum Ether, Boric Acid, Sulfuric Acid, Hydrochloric Acid, Sodium Hydroxide, Bromocresol Green, Methyl Red, Selenium Dioxide, Potassium Sulfate, Copper Sulfate, Nutrient Agar, Potato Dextrose Agar, Citric acid.

### 2.4 Can Fabrication Process
Tin cans made of thin steel plate of low carbon content lightly coated on either side with tin metal to the thickness of about 0.00025 microns were used. Since the corrosion behavior, strength and durability of tin plate depends on the chemical composition of steel base, the base plate of MR type was used. This type of base plate is suitable for the processing of acidic foods. Fabrication of tin cans in the cylindrical shape was done by using different equipment in Food process engineering lab 2. The flattened cans were given a cylindrical shape using can reformer whose both sides were curled into cup shape by a can flanger. One end of the can was fixed to the flanged end by means of double seaming machine to form a base of can. This two pieced can was now fully filled with water to check the leakages and no leakage of water was found during inspection. Now the examined cans were ready for the processing of moringa leaves (*Moringa oleifera*) chicken curry.

### 2.5 Qualitative Testing
#### 2.5.1 Determination of Crude Protein (AOAC, 2000)
Protein was estimated by Micro kjeldahl method using 2g of moisture and fat free sample by digestion with 25 ml concentrated sulfuric acid and 2g catalyst mixture (2.5g of selenium dioxide, 100g of potassium sulfate and
220g of copper sulfate) and it was heated continuously until color changed to pale blue. The digest was cooled and distilled water was added in three portions to volume makeup of 100 ml.

Nitrogen percentage by weight =

$$\frac{\text{(Sample titre – Blank titre)} \times \text{Normality of HCl} \times 14 \times \text{volume makeup of digest} \times 100}{\text{Aliquot of the digest taken} \times \text{weight of sample} \times 1000}$$

$$\text{Protien percentage by weight} = \frac{(TV - V_3)TxV_2 \text{ x F x } 100}{V_1 \text{ x} W} \quad \text{Eq.…3.1}$$

Protein by weight = Nitrogen by weight × 6.25

Where,
V1=Volume of hydrochloric acid used in distillation
V2=Volume of water required for volume makeup.
V3=Volume of hydrochloric acid used in blank test.
T=Titrable value of ammonia sulphate.
W= Weight of sample taken for analysis.
F=Molecular weight of nitrogen present in sample.

#### 2.5.2 Determination of Crude Fat (AOAC, 2000)
5g of sample was taken in a thimble made of filter paper and was placed in butt type tube of Soxhlet apparatus. The flask of the apparatus was weighed and extraction was carried out using petroleum ether. Extraction was continued for 6 hours initially at low temperature and then at high temperature.

$$\text{Fat by weight} = (W_2 - W_1) / (W \times 100) \quad \text{Eq.…3.2}$$

Where,
$W_1$ = Weight of flask
$W_2$ = Weight of flask along with contents after oven drying.
W = Weight of sample taken for analysis

### 2.6 Microbiological Analysis
#### 2.6.1 Standard Plate Count
Nutrient agar was weighed and dissolved in distilled water in a conical flask and pH was adjusted to 7. Cotton plug was put into the mouth of flask which was further covered with aluminium foil and autoclaved at 121°C for 15 minutes. After sterilization when the temperature cooled down, the flasks were taken out. 9ml Ringer's solution was taken in six test tubes ($10^{-1}$-10-6). 1g of sample was transferred to first test tube and 1g was transferred from this into second test tube and continued up to 6th test tube. From 10-3 dilution, 1 ml of suspension was transferred to sterilized petri plates and same was repeated for 10-4, 10-5 & 10-6. Molten nutrient agar was poured into plates and rotated gently to ensure uniform distribution of cells in the medium. When solidified, the plates were placed in an incubator at 37˚C for 24 hours.

#### 2.6.2 Yeast and Mould Count
1ml of sample was transferred into 9 ml blank water test tube and shaken vigorously (label as 1:10). Using a sterile 1ml pipette aseptically, 1ml of sample from that test tube was transferred in another 9ml blank water test tube (label as 1:100) and same was repeated up to 1:1000.From each test tube 1ml sample was transferred into petri plates over which 4-5ml of PDA (Potato Dextrose Agar) media was poured into it and after that the plates were incubated at37˚C for 24 hours.

## 3. Results and Discussion
### 3.1 Effect of thermal processing on protein content of moringa leaves (*Moringa oleifera*) chicken curry during storage period
After the analytical study it was seen that the protein content decreases. Fig.3.1 shows the increasing temperature of different thermal processing treatments of ash percentage and Table 4.2 shows the effect of different treatments on percent protein content of moringa leaves (*Moringa oleifera*) chicken curry. The protein percentage at 0 days storage at temperature 110°C, 115°C and 120°C at 10, 15 and 20 minutes respectively for nine different combinations was decreased with increasing time and temperature. It was observed from the findings that proteins denatured at higher temperatures, thus decreasing their biological value and affecting their physical properties (Morgan and Kern,(1934) [4] found that during canning of chicken curry the biological activity decreased in proportion to increase in severity of heat treatment. Processes like canning and roasting may affect the physical properties of chicken curry protein adversely by changing the linkages so that they are not susceptible to enzymatic digestion (Howker *et al.*1976) [4].

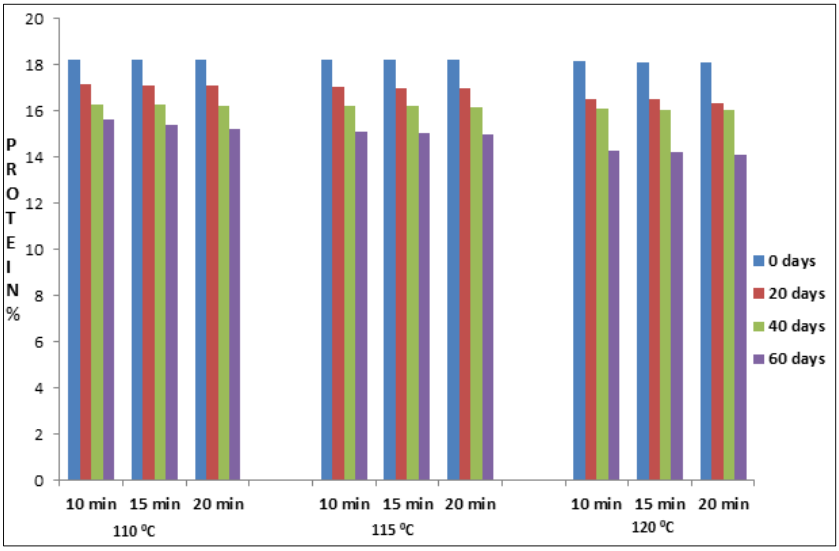


**Fig 3.1:** Effect of Different Temperature and Time Combinations on Protein (%) of moringa leaves (*Moringa oleifera*) chicken curry

### 3.2 Effect of thermal processing on fat content of moringa leaves (*Moringa oleifera*) chicken curry during storage period

Changes in fat percentage of moringa leaves (*Moringa oleifera*) chicken curry were analyzed periodically during storage period at regular intervals of 20 days to determine the effect of different time and temperature combinations on the fat percentage of the product. The fat percentage at 0 days storage at temperature 110°C, 115°C and 120°C at 10, 15 and 20 minutes respectively for nine different combinations was decreased with increasing time and temperature. The higher temperature and time combinations decreased the fat percentage of the product during storage due to the possibility of breakage of long chain fatty acid chains into individual fatty acid moiety. Oil used during product development protected the moringa leaves (*Moringa oleifera*) chicken curry from contamination and excluded oxygen. As temperature increases it affects the physical properties of meat fat **(**Reiser and Shorland, 1990) [11]. Similar findings were depicted during the fat estimation of canned meat. (Madhwaraj *et al.*1979) [8].

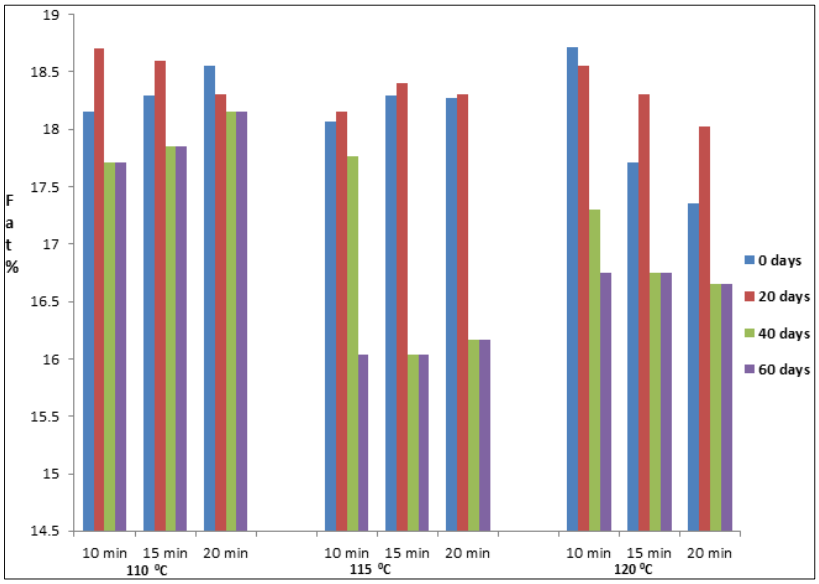


**Fig 3.2:** Effect of Different Temperature and Time Combinations on Fat (%) of moringa leaves (*Moringa oleifera*) chicken curry

### 3.3Effect of Thermal Processing on Standard Plate Count of moringa leaves (*Moringa oleifera*) chicken curry

Standard plate count of moringa leaves (*Moringa oleifera*) chicken curry were analyzed periodically during storage period at regular intervals of 20 days to determine the effect of different time and temperature combinations on the microbiological quality of the product. The standard plate count of samples processed at 120°C for similar time combinations showed significant reduce in the microbial load to optimum level which clearly depicts the shelf stability of moringa leaves (*Moringa oleifera*) chicken curry but the maximum decrease was seen in samples thermally processed at 120°C for 20 minutes. From the data obtained it was observed that thermal processing of moringa leaves (*Moringa oleifera*) chicken curry at 120°C for 20 minutes was found free from harmful pathogenic bacteria and it was observed that such samples were significantly superior to other samples. The results are in accordance with Kumar *et al.* 2007, Mohammed ali *et al.* 2013, Agathian *et al.* 2009 who studied retort process edready-to-eat foods. They also found

commercial sterility after retort processing and the entire period of the storage under different temperature. The results are in agreement with the findings of other researchers. Rajkumar *et al.*(2010) determined total viable, anaerobic, coliform, *staphylococcal, streptococcal, clostridial*and yeast and mold counts of Chettinad goat meatcurry retorted to an $F_0$ value of 12.1 minutes and showed that the product was commercially sterile.

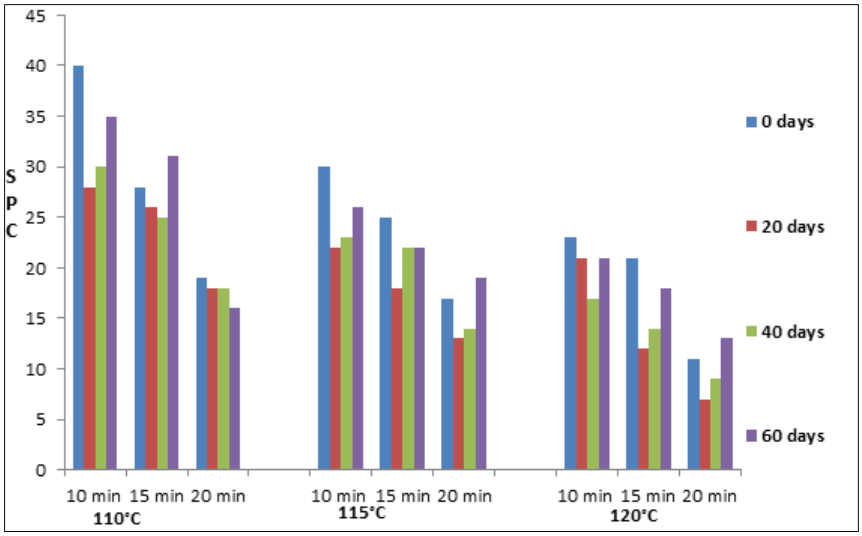


**Fig 3.3:** Effect of Different Temperature and Time Combinations on Standard plate count (%) of moringa leaves (*Moringa oleifera*) chicken curry.

**3.4 Effect of Thermal Processing on Yeast and Mold Count of moringa leaves (*Moringa oleifera*) chicken curry**

Yeast and mold of moringa leaves (*Moringa oleifera*) chicken curry were analyzed periodically during storage period at regular intervals of 20 days. The samples processed at 120°C for similar time combinations showed significant and prominent reduction in yeast and mold count of moringa leaves (*Moringa oleifera*) chicken curry depicting the shelf stability of moringa leaves (*Moringa oleifera*) chicken curry but the maximum decrease was seen in samples thermally processed at 120°C for 20 minutes. From the data obtained it was observed that samples thermal processed at 120°C for 20 minutes showed reduced yeast and mold count and such samples were significantly superior to other samples. The products remained commercially sterile during the entire period of the storage which confirmed the adequacy of the processing and safety for consumption. At high temperatures thermal treatments thermally processed cans of meat under gravy preparation have lowest decline at microbial load and a longer shelf life than other types of food packets such as sachets, pouches, glass jars.

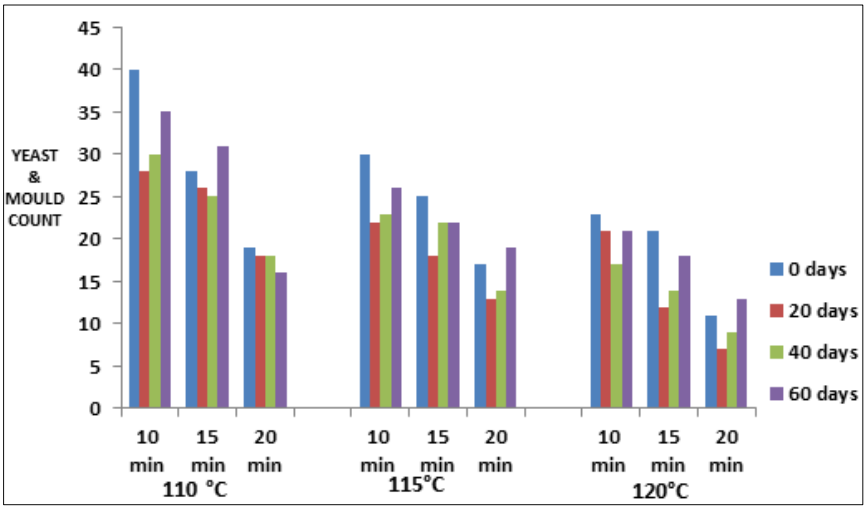


**Fig 3.4:** Effect of Different Temperature and Time Combinations on Yeast &Mould Count (%) of moringa leaves (*Moringa oleifera*) chicken curry

**3.5 Statistical Analysis**

Statistical analysis was conducted as per the data obtained from three levels of temperatures for three levels of time periods i.e. from 9 treatments and 3 replications during trial and was analyzed statistically by Analysis of Variance technique, 3 way classification to study the effect of temperature, time and days on the various physico-chemical, microbiological and sensory qualities of the moringa leaves chicken curry samples. This technique was developed by Dr. R.A. Fisher in 1923. It gives an appropriate method capable of analyzing the variation of population variance. The significant effect of treatment was judged with the help of F‘(variance ratio).

**Table 1:** A1 ANOVA table for Protein Content (%) of Moringa Leaves (*Moringa oleifera*) Chicken Curry

| | | | | | T5% | 2.024 | | |
|---|---|---|---|---|---|---|---|---|
| **Source** | **d. f.** | **S.S.** | **M.S.S.** | **F. Cal.** | **F. Tab. 5%** | **Result** | **S. Ed. (±)** | **C.D. at 5%** |
| Due to Time | 2 | 2.2548 | 1.0255 | 16.665 | 3.34 | S | 0.065 | 0.260 |
| Due to Temp | 2 | 0.6548 | 0.9866 | 5.023 | 3.34 | S | 0.113 | 0.156 |
| Due to Days | 3 | 1.6358 | 1.6525 | 6.2055 | 2.95 | S | 0.066 | 0.065 |
| Error | 28 | 1.6978 | 0.0656 | - | - | - | - | - |
| Total | 35 | 5.17 | - | - | - | - | - | - |

**Table 2:** A2 ANOVA table for Fat Content (%) of Moringa Leaves (*Moringa oleifera*) Chicken Curry

| | | | | | T5% | 2.024 | | |
|---|---|---|---|---|---|---|---|---|
| **Source** | **d. f.** | **S.S.** | **M.S.S.** | **F. Cal.** | **F. Tab 5%** | **Result** | **S. Ed. (±)** | **C.D. at 5%** |
| Due to Time | 2 | 0.0965 | 0.0898 | 0.585 | 4.25 | NS | 0.053 | 0.185 |
| Due to Temp | 2 | 0.5325 | 0.0456 | 0.554 | 6.56 | NS | 0.115 | 0.654 |
| Due to Days | 3 | 1.0565 | 0.9865 | 5.6568 | 2.55 | S | 0.065 | 0.456 |
| Error | 28 | 1.9865 | 0.0564 | - | - | - | - | - |
| TOTAL | 35 | 3.05 | - | - | - | - | - | - |

**Table 3:** A3 ANOVA table for Standard Plate Count of Moringa Leaves (*Moringa oleifera*) Chicken Curry

| | | | | | T5% | 2.024 | | |
|---|---|---|---|---|---|---|---|---|
| **Source** | **d. f.** | **S.S.** | **M.S.S.** | **F. Cal.** | **F. Tab. 5%** | **Result** | **S. Ed. (±)** | **C.D. at 5%** |
| Due to Time | 2 | 4936.1667 | 2468.0833 | 219.618 | 3.34 | S | 0.750 | 1.517 |
| Due to Temp | 2 | 3696.5000 | 1848.2500 | 164.463 | 3.34 | S | 1.499 | 3.034 |
| Due to Days | 3 | 951.4167 | 317.1389 | 28.2200 | 2.95 | S | 0.968 | 1.959 |
| Error | 28 | 314.6667 | 11.2381 | - | - | - | - | - |
| Total | 35 | 9898.75 | - | - | - | - | - | - |

**Table 4:** A4 ANOVA table for Yeast and Mold Count of Moringa Leaves (*Moringa oleifera*) Chicken Curry

| | | | | | T5% | 2.024 | | |
|---|---|---|---|---|---|---|---|---|
| **Source** | **d. f.** | **S.S.** | **M.S.S.** | **F. Cal.** | **F. Tab. 5%** | **Result** | **S. Ed. (±)** | **C.D. at 5%** |
| Due to Time | 2 | 503.1667 | 502.5833 | 99.851 | 3.34 | S | 0.448 | 0.908 |
| Due to Temp | 2 | 764.6667 | 655.3333 | 77.162 | 3.34 | S | 0.897 | 1.815 |
| Due to Days | 3 | 160.3056 | 65.4352 | 12.7890 | 2.95 | S | 0.579 | 1.172 |
| Error | 28 | 112.6111 | 3.0218 | - | - | - | - | - |
| TOTAL | 35 | 1690.75 | - | - | - | - | - | - |

**Table 5:** A5 ANOVA table for Sensory Characteristics of Moringa Leaves (*Moringa oleifera*) Chicken Curry

| | | | | | T5% | 2.024 | | |
|---|---|---|---|---|---|---|---|---|
| **Source** | **d. f.** | **S.S.** | **M.S.S.** | **F. Cal.** | **F. Tab. 5%** | **Result** | **S. Ed. (±)** | **C.D. at 5%** |
| Due to Time | 2 | 23.6006 | 11.8003 | 120.589 | 3.26 | S | 0.070 | 0.142 |
| Due to Temp | 2 | 8.2358 | 4.1179 | 42.081 | 3.26 | S | 0.140 | 0.283 |
| Due to Characters | 4 | 0.5211 | 0.1303 | 1.3314 | 2.63 | NS | 0.090 | 0.183 |
| Error | 36 | 3.5228 | 0.0979 | - | - | - | - | - |
| TOTAL | 44 | 35.88 | - | - | - | - | - | - |

## 4. Conclusion

The present study revealed that due to application of thermal processing at different time and temperature combinations, the microbial stability as well as the sensory, and the nutritive characteristics of the Chicken Curry were retained in Moringa leaves Chicken Curry. Samples processed at 110°C for 10 minutes had adequate protein content as compared to samples processed at other temperature and time combinations (0day-18.21%,20day-17.15%, 40 day-16.25,60day-15.60%). Samples processed at 120°C for 10 minutes had adequate fat content as compared to samples processed at other temperature and time combinations(0day-18.72%,20day-18.55%,40day-17.30,60day-16.75%).

Similarly the maximum decline in the microbial load was depicted after the Moringa leaves Chicken Curry was thermally processed at 120°Cfor 20minutes. Standard plate count (0day-20($10^4$CFU/ml),20day-10($10^4$ CFU/ml),40day-08($10^4$CFU/ml),60day-11($10^4$CFU/ml)) and Yeast and mold count(0day-11,20day-07,40day-09,60day-13) Results from the temperature measurements and microbiological tests showed that the product was commercially sterile throughout the storage period.

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