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# EFFECT OF FREEZING, FROZEN STORAGE, AND COOKING ON THE CHEMICAL CHANGES AND QUALITY CHARACTERISTICS OF LAMB MEAT. I - AMINO ACIDS AND QUALITY CHARACTERISTICS.

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## Introduction

In Egypt, lamb from native breeds are favorable to all citizens, in spite of their differences in social and economic standards of living. The demand for lamb is also great in the Arabian countries. The annual consumption of lamb meat amounted to 791, 0360 tons and constituted about 30% of the total slaughtered animals.

The amino acids contents of meat differ according to its type, age, breed, sex and lactation(Zlydner et al, 1973). Sherperak et al.(1959) found that in spite of the fact that lean, marbled and fatty meats had practically the same contents of arginine, histidine and cystine, the protein of fatty meat contained 50% more lysine than those of lean meat. Zagitov (1977) found that the meat of adult cattle was higher in essential amino acids than that of calves or castrates.

Generally, freezing affects meat proteins because they are very sensitive to the proteolytic changes due to the enzymatic activity, Deatherage and Haurm (1960) and Wagner (1976) found a correlation between the free amino acids and the proteolysis of meat proteins during freezing.

Cooking methods are a limiting factors in keeping the quality and the availability of essential amino acids in meat. The effect of cooking on the quality characteristics and on the differnet constituents of meat were studied by many investigators, (Usborne et al., 1968) on pork and Macy et al., (1970), and Berry et al., (1977) on beef.

On the other hand, few investigations concerning the effect of cooking after frozen storage on the chemical constituents and palatability characteristics of lamb meat were completed. Therefore, the present investigation was performed to study the effect of freezing and cooking methods on the essential and non-essential amino acids alterations occurring in lamb meat. Also, the study intended to evaluate the palatability characteristics of such meat as affected by the freezing process and method of cooking.

## Materials and Methods

### Materials:

The longissimus dorsi (L.D.) and Biceps femoris (B.F.) muscles used in this investigation were taken 12 hours after slaughter from 20 male. Marino rams (one year old) were selected from the farm of the National Research Centre at Abo-Rawash, near Cairo.

### Preparation of samples for chemical analysis:

The muscles were separated from fascia, bones and visible fats. Each muscle was cut into steaks(200 gms in weight and 5 cm. in thickness), packed in polyethylene bags and placed in a deep freezer at -20°C.

Samples were removed periodically, from forzen storage after 0, 1, 2, and 3 months intervals. Thawing was carried out at 5°C. The samples were then minced twice and homogonized by a conventional meat grinder prior to performing the chemical analysis.

### Preparation of processed samples:

Meat samples were thawed as previously described and then divided into three equal portions:

a- The first part was analyzed at zero time as fresh meat for assessment of the chemical composition.

b- The second part was boiled, in tap water, for one hour.

c- The third part was roasted in an overn at 170°C an internal temperature of 95°C.

### Determination of amino acids composition:

Free amino acid contents in fresh, frozen and processed lamb meat from btoh L.D. and B.F. muscles were extracted by 80% alcohol and were identified by thin layer chromatography according to the method adopted by Thompson et al.,(1961).

### Seosory Evaluation of Cooked Lamb Meat:

Cooked lamb samples were sliced into 2 cm thickness crops. Each slice was cut into uniform pieces and served hot to the panel members. Fifteen panelists (highly qualified) were asked to judge the palatability characteristics of the different treatments. The taste panel used a nine points scale for grading the meat on tenderness, juiciness and flavor as described by Berry et al., (1977).

## Results and Discussion

### Amino acids content of fresh lamb meat:

Table (1) represents the amino acid content of both longissimus dorsi (L.D) and Biceps femoris(B.F.) muscles of fresh, boiled and roasted lamb. The nineteen amino acids which were detected in each meat sample.

were separated into essential and non-essential ones.

From the results tabulated in Table (1) it could be observed that there was a great variation in the amino acids content of fresh samples from both muscles under investigation. The total essential amino acids in the L.D muscle reached as much as 18 gm/100 mg, while it was only 14.97 mg/100 mg in the B.F. muscle. Meanwhile, L.D muscle was characterized by high concentrations of histidine, valine, methionine and phenylalanine. The B.F. muscle contained more arginine and more lysine when compared with that of L.D. On the other hand the amount of non-essential amino acids were almost similar in both muscles as it was 6.98 mg/100 mg in B.F. and 7.42 mg/100 mg in the L.D. These results are quite close to those reported by Rice (1978) who found higher amounts of essential amino acids especially lysine, methionine, arginine and valine.

Table (1) shows that boiling and roasting have different effect on the amino acids content. The effect also differed according to the type of muscle being treated.

Table (1):Amino acids content of Longissimus Dorsi and Biceps Femoris muscles of fresh, boiled and roasted lamb meat.

| Amino Acids mg/100 mg sample | Longissimus Dorsi | | | Biceps Femoris | | |
|---|---|---|---|---|---|---|
| | Fresh | Boiled | Roasted | Fresh | Boiled | Roasted |
| **Essential** | | | | | | |
| Iso-leucine | 0.11 | 0.13 | 0.43 | 0.08 | 0.42 | 0.39 |
| Methionine | 0.85 | 0.73 | 0.89 | 0.46 | 0.59 | 0.54 |
| Ph. Alanine | 0.77 | 0.20 | 0.53 | 0.23 | 0.21 | 0.22 |
| Threonine | 0.22 | 0.25 | 0.27 | 0.23 | 0.57 | 0.27 |
| Tryptophane | 0.14 | 0.38 | 0.15 | 0.11 | 0.19 | 0.19 |
| Valine | 1.63 | 1.32 | 1.64 | 0.85 | 1.59 | 2.06 |
| Arginine | 0.89 | 2.48 | 1.69 | 2.78 | 0.91 | 1.55 |
| Histidine | 8.00 | 3.47 | 5.02 | 1.96 | 2.22 | 5.01 |
| Lysine | 5.22 | 4.98 | 3.40 | 8.27 | 4.89 | 4.70 |
| Total | 18.09 | 13.94 | 14.02 | 14.97 | 11.59 | 14.93 |
| **Non-Essential** | | | | | | |
| Alanine | 1.09 | 1.04 | 0.84 | 1.06 | 0.96 | 0.56 |

Table (1) Cont.

| Amino Acids mg/100 mg sample | Longissimus Doris | | | Biceps Femoris | | |
|---|---|---|---|---|---|---|
| | Fresh | Boiled | Roasted | Fresh | Boiled | Roasted |
| **Non-Essential**(Con.) | | | | | | |
| Aspartic Acid | 0.61 | 1.29 | 0.93 | 0.96 | 0.96 | 0.56 |
| Glycine | 1.47 | 1.36 | 0.93 | 1.38 | 1.25 | 0.86 |
| Glutamic Acid | 1.28 | 0.48 | 1.06 | 0.89 | 0.43 | 0.55 |
| Proline | 0.32 | 0.22 | 0.55 | 0.31 | 0.32 | 0.42 |
| Serine | 1.33 | 1.59 | 1.25 | 1.50 | 0.57 | 1.22 |
| Tyrosine | 0.40 | 0.23 | 0.67 | 0.19 | 1.23 | 0.26 |
| OH-proline | 0.35 | 0.39 | 0.16 | 0.28 | 0.39 | 0.12 |
| Cystine | 0.57 | 0.38 | 0.86 | 0.68 | 0.39 | 0.59 |
| Total | 7.42 | 6.98 | 7.25 | 6.98 | 6.50 | 5.14 |

In L.D. muscle there was an increase in arginine and aspartic acid concentrations, which might be due to the destruction of some proteins by heating. However, there was a significant decrease in histidine; which is suggested to be due to the release of some of the imidazolium groups of histidine which are masked in the native protein and are released upon heating by the unfolding of actomyocin (Bognar and Antal, 1977). Furthermore, proline concentration in L.D. and B.F. muscles were found to decrease after boiling. Other amino-acids, such as alanine, cystine, phanylalanine and OH-proline were also decreased. The decrease in OH-proline in both L.D. and B.F. muscles might be due to the change of collagen to gelatin by heating. Meanwhile, during roasting, the reduction in the amino acids, particularly the essential ones, were less pronounced than that occurring during boiling. This phenomenon was true in both muscles under investigation. However, most of the loss occurred in lysine, methionine and tryptophane. This reduction in the free amino acids during roasting might be due to the browning reaction between muscle proteins and reducing sugars in the meat tissues (Hornstein, 1967).

Effect of frozen storage and cooking on the amino acids content of lamb:

Lamb samples from both L.D. and B.F. muscles were frozen at -20$^{0}$C. Samples were taken periodically after 0, 1, 2 and 3 months intervals. Then the samples were thawed and either cooked by boiling or roasting. Next, all the samples were analyzed for their amino acids content.

The results indicated an increase in the total amino acids content in the raw samples after freezing for 1 month. However, the proportion of every single amino acids within the group differed markedly. For example, in the L.D. muscle there was a decrease in methionine, tryptophane and phenylalanine, while there was a pronounced increase in threonine, valine, histidine and lysine. Meanwhile, in B.F. muscle the decrease only occurred in arginine, while all the other amino acids increased. This increase might be attributed to the effect of proteolytic enzymes on meat proteins. Figs. (1,2) also illsutrates the effect of cooking on the contents of some of the essential amino acids (i.e., isoleucine, methionine, valine, histidine and lysine) which changed markedly in both B.F. and L.D. muscles. In L.D. muscle (Fig. 1) roasting induced a greater reduction in those

amino acids when compared to boiling. However, the effect of the two methods of cooking were less pronounced in the B.F. muscle (Fig. 2). During boiling histidine had the most drastic decrease. The percentage decrease reached 52.35%. In the other amino acids the percentage decrease ranged from 14.28% to 47.97%. During cooking, the decrease in some amino acids concentration, could be attributed to the denaturation and coagulation of meat proteins, in addition to the destruction of some amino acids by heating. However, the decrease in the amino concentration of boiled samples might be due to the release of some free amino acids in the broth during boiling (Macy et al., 1970).

As the storage time increased, the changes which took place in the amino acids content of meat also increased. Generally, there was a continuous decrease in the total essential amino acids of both muscles as the storage time increased, when compared with fresh samples (table 1). However, some of the non-essential amino acids decreased, while the others increased. The same tables show an increase in some of the essential amino acids, methionine, threonine, arginine and histidine, and decrease for isoleucine, cystine and valine when the lamb was boiled. On the other hand, most, the essential and non-essential amino acids decreased after roasting of the two muscles. However, tryptophane remained almost constant in all samples. Boiled meat contained more essential amino acids (10.88 mg/100 mg sample) than roasted meat (6.08 mg/100 mg sample). These results differ from those reported by Clark et al., (1965) who found that roasting at an internal temperature of 72°C did not affect the essential amino acids. However, their results were concerned with beef, and the different species will react differently with the cooking methods (Macy et al., 1964).

The increase in the total amino acids content of raw samples, especially the essential ones, could be attributed to the continuous enzymatic hydrolysis of meat proteins into simple peptides and amino acids (Wagner, 1976). The decrease in the amino acids content might be due to the reaction of these free amino acids with the degradation products of lipids oxidation during frozen storage over a long time period (i.e. 3 months). The present results should be coinside with those reported by Kuzmin and L'tsiue (1969).

After roasting almost all the amino acids concentrations decreased. While, the boiled samples contained higher concentrations of all the amino acids. This increase might represent the net difference between the amino acids formed and those destroyed by heating (Macy et al., 1970). The same data also indicated a continuous decrease in the sulfur containing amino acids (methionine and cystine). This might be due to the release of the sulfur components during cooking, or to the formation of large quantities of hydrogen sulfide during cooking (Meahi et al, 1964).

In conclusion, frozen storage of lamb for a period of 3 months, is not favorable for maintaining the meat quality, as the reuslts showed a significant loss in the essential amino acids content.

Effect of freezing prior to cooking on the palatability characteristics of lamb:

Average flavor, juiciness and tenderness scores of cooked lamb meat are tabulated in table (2). It is clear from the results that, B.F. muscle was lower in quality than L.D. as it attained lower scores in all parameters examined. However, this might be due to the difference in the chemical structure between the two muscles. Meanwhile, the cooking method affected the palatability scores differently. Roasting always attained lower scores than boiling in both muscles.

The effect of frozen storage before cooking seemed to adversely affect the palatability characteristisc of lamb meat in both muscles under investigation. As the time of stroage increased, these characteristics decreased drastically (Figs. 3 & 4). However, it was much more pronounced in roasted samples than in boiled ones. It seems that roasting is not a suitable method for cooking lamb meat, especially if it had been previously preserved by freezing. On the other hand, boiling induced better scores even after storage for three months at -20°C. This could be due to the effect of type of heat used, as moist heat might induce more tenderness in meat than dry heat. Similar results and conclusions were also reported by Ferger et al.,(1972). The decrease in acceptability scores, especially in flavor, might be due to various chemical deteriorations which take place in the lipids and protein fractions during frozen storage either by enzymatic action or by destruction some of the flavor components.

The results in table (2) also indicated that juiciness scores were related to tenderness and that both of them decreased during storage. This could be attributed to loss of sizeable amounts of drip during thawing of the meat before cooking and hence, render the muscle fibers drier and thus inducing thoughness. It is obvious from the results that as the tenderness and juiciness decreased the number of chews required for complete mastication increased.

It could also be noticed from the results that frozen storage is not the best way for keeping the acceptability scores of lamb meat in high order. Also the best cooking method for maintaining the palatability characteristics was found to be moist heat (boiling) and not dry heat (roasting).

It could be concluded from the results that the score values of palatability were reduced in both boiled and roasted lamb as the storage period of freezing prior to cooking increased. Also, a clear relationship was observed between the amino acids content and palatability characteristics of cooked lamb. In the case of roasted lamb, lower score values of palatability were observed when compared with those obtained from boiled lamb. This phenomenon could be explained on the basis that the free amino acids in lamb meat enhances the browning reaction which takes place during cooking and improve the quality characteristics of meat.

Table(2): Average palatability characteristics of L.D. and B.F.muscles of lamb frozen for 1,2,and 3 months then boiled and roasted.

| Storage Period | Treatment | Flavor | | | | Tenderness | | Juiciness | | No. of chews | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Taste | | Odor | | | | | | | |
| | | L.D. | B.F. | L.D. | B.F. | L.D. | B.F. | L.D. | B.F. | L.D. | B.F. |
| 0 time | Boiled | 7.4 | 7.4 | 7.4 | 6.2 | 8.5 | 7.6 | 8.6 | 7.8 | 2.2 | 2.7 |
| | Roasted | 7.4 | 5.8 | 7.4 | 6.1 | 6.0 | 5.2 | 6.0 | 4.2 | 7.3 | 3.4 |
| 1 month | Boiled | 7.4 | 6.5 | 5.4 | 5.2 | 7.6 | 7.6 | 8.0 | 6.2 | 5.1 | 4.4 |
| | Roasted | 6.3 | 5.8 | 6.5 | 5.5 | 5.6 | 5.6 | 3.8 | 4.7 | 9.3 | 6.5 |
| 2 months | Boiled | 7.6 | 5.7 | 5.0 | 3.7 | 7.0 | 6.2 | 7.6 | 6.0 | 10.5 | 8.7 |
| | Roasted | 4.3 | 4.0 | 3.3 | 2.8 | 4.3 | 3.7 | 4.6 | 3.3 | 12.6 | 15.3 |
| 3 months | Boiled | 7.6 | 5.1 | 4.8 | 3.1 | 6.9 | 6.0 | 6.0 | 6.0 | 11.3 | 10.6 |
| | Roasted | 3.3 | 3.2 | 3.0 | 2.1 | 3.7 | 3.1 | 4.2 | 2.8 | 14.2 | 16.7 |


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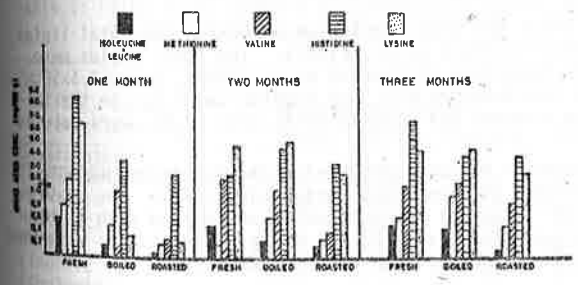
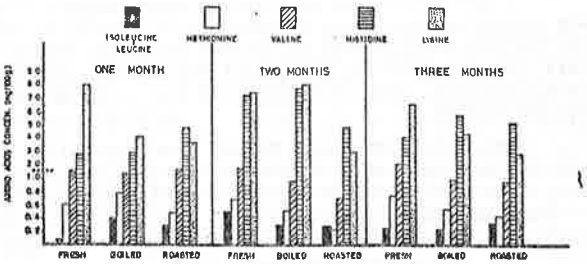
FIG.(1): EFFECT OF FROZEN STORAGE AND COOKING ON SOME OF THE ESSENTIAL AMINO ACIDS IN LAMB MEAT.



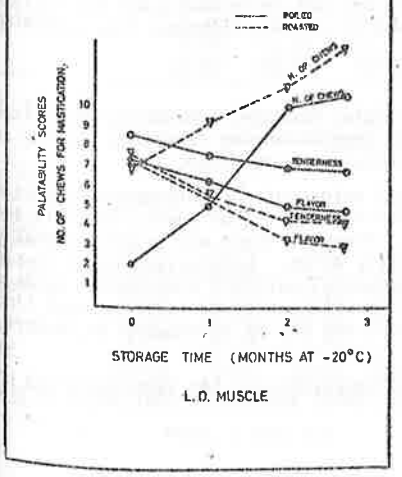

L.D. MUSCLE

FIG.(2) EFFECT OF FROZEN STORAGE AND COOKING ON SOME OF THE ESSENTIAL AMINO ACIDS IN LAMB MEAT.



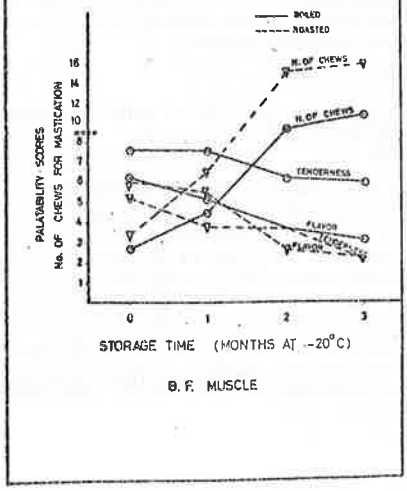

B. F. MUSCLE

FIG.(3): EFFECT OF FROZEN STORAGE AND COOKING ON THE PALATABILITY CHARACTERISTICS OF LAMB MEAT.




L.D. MUSCLE

FIG.(4): EFFECT OF FROZEN STORAGE AND COOKING ON THE PALATABILITY CHARACTERISTICS OF LAMB MEAT.




B. F. MUSCLE