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CHEMICAL AND MICROBIAL EVALUATION OF BEEF FRANKFURTER PRODUCT AT DIFFERENT PROCESSING STAGES

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ABSTRACT

A total of one hundred and twenty five random samples (twenty five) from each of frozen forequarter meat, frozen flank meat, ground meat, meat emulsion and final product were collected during production of beef frankfurter in large modern meat processing plant in Egypt. The samples were transferred directly to the laboratory under aseptic condition with a minimum of delay. The samples were subjected to chemical and microbiological examination . The obtained results revealed that, the chemical and microbiological composition of forequarter , flank and ground meats compliance with the *Egyptian standard specifications (1991)* of frozen meat and ground meat . On the other hand, 5 (20%) of the samples of final product contained nitrite , phosphate , ascorbic and starch more than the recommended by *Egyptian standard specification (2000)* limits , moreover, the microbiological findings of the examined samples declared very low bacterial load in final product and were negative for E. coli , Moulds and Yeasts, Colstridium perfringens and Salmonella while, 2(8%) samples exceeded the permissible limits which contained Coliforms and Staphylococcus aureus.

Coliforms, E.coli, Staphylococcus aureus and total Moulds and Yeasts were found in meat emulsion more than the frozen and ground meats . The recommended points to produce beef frankfurter with high quality and safe for human consumption were discussed .

INTRODUCTION

Frankfurter is one of delicatessen meat products which is available in cased form , usually do not undergo further preparation or cooking at the hands of consumers . The operational processing of frankfurter begins with grinding of frozen meat chunks of variable size, shape and fat content (frozen forequarter and frozen flank meats) to yielding finished product contain fat not more than 20% as recommended by ***Egyptian standard specification (2000)***, and then chopped in a cutter with water, spices, seasonings, curing ingredients and starch, then the mixture chopped to an emulsion by

means of the cutter. The emulsion is extruded into cellulose casings then cooked to an internal temperature of 69 to 72°C . The cooked product are cooled to an internal temperature of 4 °C or below, then peeled mechanically and packaged .

In spite of continuing programs made in food quality and safety, several food borne disease outbreaks have been reported, and the most frequently identified factors were cross contamination, contaminated raw meat/ ingredients poor personal hygiene and improper cooking *(Shapro et al. 1999)* .

An important concept to recognize is that processing of frankfurter is a continuous sequence of events in which each step is an integral part of the whole, thus it is not practical to consider any one step separately or to assign more importance to one step than to other.

So the aim of this work was done to threw light on chemical and microbial evaluation of beef frankfurter during manufacturing stages .

MATERIAL AND METHODS

MATERIAL:

One hundered and twenty five samples twenty five samples each of frozen forequarter meat, frozen flank meat, ground meat, meat emulsion and final product . were collected during production of frankfurter in large meat processing plant in Egypt . The weight of each sample was 500 grams approximately . All samples were directly transferred to the laboratory under complete aseptic conditions with a minimum of delay where they were examined chemically and microbiologically .

METHODS :

Each sample was divided into two equal portions for the chemical and microbiological examination .

Chemical examination :

Each sample was thoroughly mixed and homogenized in meat blender where it was ready for use . The forequarter, flank and ground meats were subjected to quantitative analysis of moisture, protein, fat, ash, pH value and total volatile nitrogen (T.V.N) , while the meat emulsion and final product in addition to the tests previously mentioned were subjected to quantitative analysis of nitrite, phosphate, starch and ascorbic acid . The chemical analysis were carried out according to the technique recommended by *Pearson (1984)* .

Microbiological examination :

Preparation of samples:

The samples were prepared according to *APHA, (1992)* as follows, each sample was perfectly mixed , then 25 gm of each well added aseptically to 225ml sterile 0.1% peptone water solution to make a dilution of 1:10 from which further decimal dilutions were prepared for the following tests:

1- **Total bacterial count :** The count was carried out according to *ICMSF (1996)* .
2- **Total Coliforms count :** The count was carried out according to *APHA, (1985)* by using violet red bile agar .
3- **Determination of E. coli :** The test was carried according to *Feng and Hartman,(1982)* by using (MUG) flourogenic

method for rapid detection of E. coli.

4- **Determination of Staphylococcus aureus** : By drop technique *(ICMSF, 1978)* Using Baired Parker's medium *(Smith and Baird Parker, 1964).*

5- **Enumeration of Moulds and Yeasts** : The count was carried out according to *Mislivec et al (1992)* by using sabouraud dextrose agar .

6- **Detection of Salmonellae** : According to *ISO 1993-6579*

7- **Determination of Clostridium perfringens:** It was carried out according to *(ICMSF, 1978)* by using Reinforced clostridium medium . Biochemical identification of the suspected isolates were carried out according to *Willis (1977)* .

RESULTS AND DISCUSSION

I- Chemical examination:

The chemical examination of frozen forequarter and frozen flank meats were carried out not only to indicate its nutritive values but also used as a guide to obtain final product (beef frankfurter) met the *Egyptian standard specification (2000)* . Also pH and total volatile nitrogen used for verification of freshness and good quality of used meat *(Pearson, 1984).*

The data presented in (Tables1&2) provided that, the mean values of moisture, protein, fat, ash, pH value and total volatile nitrogen (T.V.N) for forequarter meat were 64.15±0.60, 19.7±0.2,15.3±0.57, 0.92±0.02, 5.8±0.04 and13.96±0.36 respectively, while, in flank meat were 51.93±1.23, 14.86±0.27, 32.42±1.14, 0.78±0.01, 5.84±0.03 and15.18±0.40 respectively . These results nearly similar to that reported by *Abd El-Hafiez and Abd El- Shaheed (2004)* and lie within the *Egyptian standard specification (1991)* of frozen meat .

Concerning ground meat the results obtained in this study revealed that, the mean values of moisture, protein, fat, ash, pH value and total volatile nitrogen (T.V.N) were 59.89±1.42, 17.07±0.29, 22.07±0.59, 0.96±0.02, 5.83±0.03 and15.33±0.42 respectively, (Table,3). These findings were in agreement with the *Egyptian standard specification (1991)* for ground meat .

The results obtained in (Tables 4&5) declared that, the mean values of moisture, protein, fat, ash, pH value, total volatile nitrogen (T.V.N), nitrite(ppm), phosphate(ppm), ascorbic(ppm) and starch % of meat emulsion were 61.64±0.58, 15.86±0.20, 21.56±0.54, 2.1±0.05, 6.23±0.02, 17.54±0.19, 154.64±5.3, 3203±34.47, 374.6±8.12 and 9.86±0.30 respectively, but for final product were 55.3±0.47, 16.54±0.34, 19.42±0.34, 2.5±0.06, 6.3±0.02, 17.48±0.2, 113.9±2.3, 3160±52.8, 305.2±11.8 and 9.4±0.3 respectively. Nearly similar results were achieved by *Abd El-Hafiez(1995)* but not agreeable with that recorded by *Bushway et al.(1988)* and *Beebe et al. (1989).*

From the above results it was noticed that, all examined samples of final product contained moisture%, ash%, pH value, total

volatile nitrogen (T.V.N), phosphate and ascorbic within the permissible according to the ***Egyptian standard specification (2000)***, while five samples exceeded this specification due to contained protein less than 15% and fat more than 20% and these non conformities may be attributed to additional flank meat which contain large amount of fat more than forequarter meat. Moreover, contained starch and nitrite more than the safe limits which may be due to defects in measuring equipments , so these equipments shall be continually calibrated or verified at specified intervals or prior to use ***(ISO 9001:2000)*** .

Nitrite itself is not toxic in small amounts but it can form nitrosamines which are carcinogens. Nitrosamines are formed when nitrite react with so called amines. The average daily intake value for nitrite is 0.2mg/kg body weight. Nitrite used with salt as a pickling salt and act as preservative, reddening, flavor modification and antioxidative action ***(Jurgen,1993)***.

Ascorbic acid protect food, improve its quality and acceptability by their antioxidant properties and by their consequent inhibition of the destructive effects of oxygen. In addition it inhibits formation of carcinogenic nitrosamines ***(Nawar,1985)***.

Phosphates are added to increase the water binding capacity and thereby the yield of finished product. Also it chelate trace metal ions and retard development of rancidity in frankfurter product ***(Jakobson, 1990)*** .

Although starch is carbohydrate, it do not ferment unless enzymatically hydrolyzed . It used as binders and as extenders because of relatively low price in relationship to good quality meat.

Microbiological examination:

The achieved results reported in Table(6) revealed that, the incidence and the mean values of total bacterial count, Coliforms count, E.coli, Staphylococcus aureus and total Moulds and Yeasts count in frozen forequarter meat were (100%),$1.1x10^5 \pm 3.3x10^4$, (32%), $1.4x10^2 \pm 5.9x10$, (24%), $5.6x10 \pm 3.3x10$, (28%), $2.6x10^2 \pm 1x10^2$ and (32%), $2.6x10^2 \pm 8.9x10$ CFU/g. respectively, while in frozen flank meat were (100%), $1.3x10^5 \pm 3.6x10^4$, (32%),$1.9x10^2 \pm 8.4x10$, (24%), $6.5x10 \pm 3.9x10$, (28%), $3.3x10^2 \pm 1.3x10^2$ and (32%), $2.8x10^2 \pm 9.9x10$ CFU/g. respectively,(Table,7), on the other hand, Colstridium perfringens and Salmonella could not be isolated from all examined samples. Nearly similar results were obtained by ***Noha, (1997)*** but higher results were recorded by ***Tolba, (1994)*** .

The above results indicated that, 32% of examined samples exceeded the permissible limit that recommended by the ***Egyptian standard specification (1991)*** due to containing Moulds and Yeasts but other bacteriological aspects lie within these limits .

Data given in Table (8) showed that, the incidence and the mean values of total bacterial count, Coliforms count, E.coli, Staphylococcus aureus and total Moulds and Yeasts count in ground

meat (100%),$1.4x10^5$± $4x10^4$,(32%),$2.3x10^2$ ±$1.1x10^2$,(28%),$1.4x10^2$ ±6.5x10,(36%),$6.1x10^2$ ±$2x10^2$ and (32%),$3.3x10^2$ ±$1.1x10^2$ CFU/g. respectively, but Colstridium perfringens and Salmonella could not be isolated from all examined samples . Higher results were reborted by ***Sohair, (2000)***.

The above results declared that, only slightly increasing in counts of total aerobic bacteria, Coliforms and Moulds and Yeasts were observed , while, noticed slightly increasing in incidences and counts of E. coli and Staphylococcus aureus in this stage in compared with the previous one of manufacturing which may be due to bad handling of raw meat and unsatisfactory hygienic condition during preparation and mincing ***(Ghonium,1992)***. Moreover, and according to the ***Egyptian standard specification (1991)*** of ground meat 32% of examined samples exceeded the safe limit due to hading Staphylococcus aureus more than 100 CFU/g. while other bacteriological findings were in agreement with this specification .

Data illustrated in Table (9) showed that, the incidences and the mean values of total bacterial count, Coliforms count, E.coli, Staphylococcus aureus and total Moulds and Yeasts count in meat emulsion were (100%), $1.9x10^5$±$5.4x10^4$, (60%), $3.8x10^2$±$1.6x10^2$, (36%),$1.8x10^2$ ± 7.3x10, (40%), $7.4x10^2$±$2.2x10^2$ and (32%), $4x10^2$±$1.4x10^2$ CFU/g. respectively, furthermore, Colstridium perfringens and Salmonella could not be isolated from examined samples . This agree with the results recorded by ***Heiszler (1972)*** .

It is clear from the above data that, markedly highest in counts of total bacterial and total Moulds and Yeasts , in addition increasing in incidences and counts of Coliforms, E. coli and Staphylococcus aureus in this stage when compared with the former stages of processing and this may be attributed to the different additives used especially spices whereas, the microbiological content and the quality of meat emulsion might be adversely affected by the bacteria and mould introduced with spices ***(Palumbo et al. 1979)*** .

The summarized results in Table (10) showed that, the incidences and the mean values of total bacterial count, Coliforms count and Staphylococcus aureus count in final product were (100%), $9.3x10^2$±$1.9x10^2$, (8%), 2±1.4 and (8%), 5.6±3.9 CFU/g. respectively, Nearly similar findings were achieved by ***Palumbo et al. (1974)*** and ***Bernard et al. (1976)*** .

It is clear from the above data that, greatest increment in reduction of bacterial count were observed moreover, Colstridium perfringens , Salmonella , E. coli and Mould and Yeast were not recovered from all examined samples and this is attributed to cooking processes ***(Jurgen, 1994)*** . On the other hand, both of Coliforms and Staphylococcus aureus could be isolated from 2(8%) of examined

meat (100%),$1.4x10^5$± $4x10^4$,(32%),$2.3x10^2$ ±$1.1x10^2$,(28%),$1.4x10^2$ ±6.5x10,(36%),$6.1x10^2$ ±$2x10^2$ and (32%),$3.3x10^2$ ±$1.1x10^2$ CFU/g. respectively, but Colstridium perfringens and Salmonella could not be isolated from all examined samples . Higher results were reborted by ***Sohair, (2000)***.

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It is clear from the above data that, greatest increment in reduction of bacterial count were observed moreover, Colstridium perfringens , Salmonella , E. coli and Mould and Yeast were not recovered from all examined samples and this is attributed to cooking processes ***(Jurgen, 1994)*** . On the other hand, both of Coliforms and Staphylococcus aureus could be isolated from 2(8%) of examined

samples which may be resulted from post processing contamination from food handlers ***(Palumbo et al. 1977 and Thatcher and Clark,1978)*** . On the other view, and according to the ***Egyptian standard specification (2000)*** of frankfurter , 2(8%) of examined samples exceeded the safe limits that recommended by this specification due to presence of Coliforms and Staphylococcus aureus while other bacteriological investigations were in agreement with this specification .

This survey shows that, the chemical characteristics of beef frankfurter not only depends on the chemical composition of raw meat but also on the additives and binders used in processing where, all the examined samples of raw meat had chemical composition lie within the limits that recommended by the Egyptian authorities, but 5(20%) samples of final product exceeded this limits. On the other hand, the total bacterial count of finished frankfurter indicated that, very low numbers survive the heating step, also were negative for E. coli and Moulds and Yeasts while 2(8%) samples exceeded the permissible limits set by the Egyptian authorities due to containing Coliforms and Staphylococcus aureus .

So in order to produce beef frankfurter safe for human consumption, good manufacturing practices and sanitation standard operation procedures shall be applied during various stages of manufacturing in parallel by using of high quality and safe raw meat, additives and binders.

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RESULTS

Table (1) Statistical analytical results of chemical analysis of forequarter meat used for processing of frankfurter product

	Moisture %	Protein %	Fat %	Ash %	pH value	T.V.N value
Min	59.46	17.9	7.9	0.79	5.6	10.9
Max	69.68	22	19.9	1.2	6.1	17.8
Mean ±SEM	64.15 ±0.60	19.7 ±0.2	15.3 ±0.57	0.92 ±0.02	5.8 ±0.04	13.96 ±0.36

Min= Minimum Max= maximum
SEM= Standard error of mean T.V.N = Total volatile nitrogen

Table (2) Statistical analytical results of chemical analysis of flank meat used for processing of frankfurter product

	Moisture %	Protein%	Fat %	Ash %	pH value	T.V.N value
Min	40.59	13	25	0.7	5.7	11.9
Max	59.08	16.8	43	0.84	6.1	18.8
Mean ±SEM	51.93 ±1.23	14.86 ±0.27	32.42 ±1.14	0.78 ±0.01	5.84 ±0.03	15.18 ±0.40

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Table (3) Statistical analytical results of chemical analysis of ground meat used for processing of frankfurter product

	Moisture %	Protein %	Fat %	Ash %	pH value	TVN value
Min	53.10	14.8	18.2	0.80	5.7	11.2
Max	62.53	19.9	31	1.3	6.1	18.5
Mean ±SEM	59.89 ±1.42	17.07 ±0.29	22.07 ±0.59	0.96 ±0.02	5.83 ±0.03	15.33 ±0.42

Table (4) Statistical analytical results of chemical analysis of meat emulsion used for processing of frankfurter product

	Min	Max	Mean±S.E.M
Moisture %	53	67	61.64±0.58
Protein %	14.2	18.5	15.86±0.20
Fat %	15	26	21.56±0.54
Ash %	1.7	2.8	2.1±0.05
pH value	6.1	6.5	6.23±0.02
TVN value	15.8	19.1	17.54±0.19
Nitrite (ppm)	110	188	154.64±5.3
Phosphate (ppm)	2800	3500	3203±34.47
Ascorbic (ppm)	320	450	374.6±8.12
Starch %	7.8	13.8	9.86±0.30

Table (5) Statistical analytical results of chemical analysis of final product (frankfurter product)

	Min	Max	Mean±SE
Moisture %	52	61.6	55.3±0.47
Protein %	13.6	19.2	16.54±0.34
Fat %	16.9	22.8	19.42±0.34
Ash %	1.9	3.1	2.5±0.06
pH value	6.1	6.6	6.3±0.02
T.V.N. value	16.1	19.2	17.48±0.2
Nitrite (ppm)	100	135	113.9±2.3
Phosphate (ppm)	2620	3500	3160±52.8
Ascorbate (ppm)	210	410	305.2±11.8
Starch %	7.5	13.2	9.4±0.3

Table (6) Statistical analytical results of microbiological examination of forequarter meat used for producing of frankfurter

Microbial count	NO. of examined samples	Positive samples		Min	Max	Mean±SE
		NO.	%			
Total aerobic	25	25	100	$4x10^4$	$5.4x10^5$	$1.1x10^5±3.3x10^4$
Coliform	25	8	32	6x10	$1x10^3$	$1.4x10^2±5.9x10$
E. coli	25	6	24	5.3x10	$8.1x10^2$	5.6x10±3.3x10
Staph. aureus	25	7	28	$1x10^2$	$1.7x10^3$	$2.6x10^2±1x10^2$
Mould& yeast	25	8	32	$1.6x10^2$	$1.3x10^3$	$2.6x10^2±8.9x10$

N.B. Colstridium perfringens and Salmonella could not be isolated

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Table (7) Statistical analytical results of microbiological examination of frozen flank meat used for producing of frankfurter

Microbial count	NO. of examined samples	Positive samples		Min	Max	Mean±SEM
		NO.	%			
Total aerobic	25	25	100	$5x10^2$	$6x10^5$	$1.3x10^5 \pm 3.6x10^4$
Coliforms	25	8	32	7x10	$1.5x10^3$	$1.9x10^2 \pm 8.4x10$
E.coli	25	6	24	6.1x10	$9.5x10^2$	$6.5x10 \pm 3.9x10$
Staph. aureus	25	7	28	$1.5x10^2$	$1.9x10^3$	$3.3x10^2 \pm 1.3x10^2$
Mould&yeast	25	8	32	$1.8x10^2$	$1.5x10^3$	$2.8x10^2 \pm 9.9x10$

N.B. Colstridium perfringens and Salmonella could not be isolated

Table (8) Statistical analytical results of microbiological examination of ground meat used for producing of frankfurter

Microbial count	NO. of examined samples	Positive samples		Min	Max	Mean±SEM
		NO.	%			
Total aerobic	25	25	100	$1.1x10^3$	$6.2x10^5$	$1.4x10^5 \pm 4x10^4$
Coliforms	25	8	32	8x10	$2x10^3$	$2.3x10^2 \pm 1.1x10^2$
E.coli	25	7	28	$7.2x10^2$	$1.2x10^3$	$1.4x10^2 \pm 6.5x10$
Staph. aureus	25	9	36	$2x10^2$	$3x10^3$	$6.1x10^2 \pm 2x10^2$
Mould&yeast	25	8	32	$2x10^2$	$1.7x10^3$	$3.3x10^2 \pm 1.1x10^2$

N.B. Colstridium perfringens and Salmonella could not be isolated

Table (9) Statistical analytical results of microbiological examination of emulsion meat used for producing of frankfurter

Microbial count	NO. of examined samples	Positive samples		Min	Max	Mean±SEM
		NO.	%			
Total aerobic	25	25	100	$3.2x10^3$	$8.6x10^3$	$1.9x10^3 \pm 5.4x10^4$
Coliforms	25	15	60	$1.2x10^2$	$3.5x10^3$	$3.8x10^2 \pm 1.6x10^2$
E. coli	25	9	36	$1.1x10^2$	$1.4x10^3$	$1.8x10^2 \pm 7.3x10$
Staph. aureus	25	10	40	$2.5x10^2$	$3.2x10^3$	$7.4x10^2 \pm 2.2x10^2$
Mould&yeast	25	8	32	$2.2x10^2$	$2x10^3$	$4x10^2 \pm 1.4x10^2$

N.B. Colstridium perfringens and Salmonella could not be isolated

Table (10) Statistical analytical results of microbiological examination of final product (frankfurter)

Microbial count	NO. of examined samples	Positive samples		Min	Max	Mean±SEM
		NO.	%			
Total aerobic	25	25	100	$1x10^2$	$2.2x10^2$	$9.3x10^2 \pm 1.9x10^2$
Coliforms	25	2	8	2x10	3x10	2±1.4
Staph. aureus	25	2	8	6x10	8x10	5.6±3.9

N.B. Colstridium perfringens , Salmonella , E. coli and Mould&yeast could not be isolated