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# Studies on quality and safety indices of some meat products

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**Abstract**

The general objectives of this research were to evaluate the storage conditions, quality, safety and shelf life validity of twelve meat products (6, samples of beef burger and 6 samples of beef kofta), which they had been collected from local market in the city of Baghdad, republic of Iraq and that is throughout their microbiological, chemical, physical and sensory properties. Between all six beef burger samples: The best sample in the microbiological examinations was sample (1) and contain the highest ($P \leq 0.05$) crude protein content. The lowest TVN and TBA values was in sample (3). The best sample in the sensory evaluation was sample (5). Between all of the six beef kofta samples: The best sample in the microbiological examinations was sample (5). The highest crude protein content was in sample (4), while the lowest TVN value was in sample (3). The lowest TBA value and the best in the sensory evaluation founded in sample (5). These results revealed an improbable storage conditions, a microbiological spoiled sample, foodborne illness threats and less value meat products of couple of samples in the Iraqi local meat products markets.

**Key words:** Meat products, Shelf life, Quality and Safety.

## Introduction

Meat and meat products is an important part of our daily diet and could be considered as excellent sources of essential nutrients **(Mehta *et al*., 2015)**. Meat products are foods in which meat is the main ingredient, mixed with other components such as fat, water, salt and curing ingredients, spices, ...etc. **(Cobos and Diaz, 2015)**. Meat products initially developed to make palatable products from less desirable cuts of meat, they can be manufactured from meat containing high levels of fat or connective tissue or meat and fat trimmings produced in the preparation of high value and upgrading of medium value cuts **(Tobin *et al*., 2012)**. The development of a global meat market and the increase of distance between producers and consumers have increased the use of freezing as a preservation technique **(Leygonie *et al*., 2012).** Meat products are mostly stored in freezing conditions as unpacked and exposed to some quality losses such as oxidative changes and moisture loss causing freezer burn. In fact, muscle foods are under constant oxidizing conditions that results in a damage of lipids and proteins **(Estevez, 2011 and Min and Ahn, 2005)**.

The chemical and nutritional composition of each meat product is greatly varied from one product to another as it contains different kinds of tissues and sometimes a mixture of meat of various organs burger is the product which is prepared from one or mix of fresh, chilled or frozen red meat, seasoned with spices and salt for the food as desired **(Lawrie, 1998).** The product should be free from foreign substances and no other additives should be added. Burger could be made in different shapes, sizes and weights and packaged in healthy containers and its must be frozen quickly and stored at temperature do not exceed -18 C°. **(IQS, 1990).** kofta (Kabab) is the product which is prepared from one or both of (Fresh or chilled red meat) or frozen red meat, chopped, addition spices and salt as desired, and its allowed the addition of fillers, expanded and bonded and packaged in containers allowed healthily to be frozen quickly and stored at a temperature not exceeding -18 C° **(IQS, 1990)**. Meat is an easily spoilable commodity **(Malik and Sharma, 2014)**. Lipid oxidation is one of the major factors that limit the shelf-life of meat products **(Garcia-Lomillo *et al*., 2017).** Processing conditions such as mincing, salt addition, freezing rate and storage time promote the intensity of oxidative reactions **(Naveena *et al*., 2008 and Soyer *et al*., 2010)**. There are many studies showing the effects of oxidation on muscle foods during frozen storage **(Sebranek *et al*., 2005; Soyer *et al*., 2010 and Tironi *et al*., 2010)**. Briefly, oxidative reactions in muscle foods may cause the loss in quality properties such as sensorial characteristics, functional properties and nutritional value; as a result, shelf-life of muscle foods is shortened **(Turgut *et al*., 2017)**. Investigations in food science and technology, whether by the food industry, governmental agencies, or universities, often require determination of food composition and characteristics. All food products require analysis as part of a quality management program throughout the development process (including raw ingredients), through production, and after a product is in the market. **(Nielsen, 2009)**. Illness resulting from foodborne disease has become one of the most widespread public-health problems in the world today **(Josephson *et al.*, 1997 and WHO, 2012)**. This research aimed to evaluate the quality characteristic,

microbial safety and shelf life validity of twelve meat products samples collected from local retail market.

**Methods and Materials**

**Materials:**

- Twelve meat product's samples were collected from Iraqi retail markets in the Baghdad city between (August-September 2016) as the following: Six samples of beef burger and six samples of frozen beef "kofta" locally named "Kabab".

**Table 1.** Storage temperature/humidity average of 24 hours, sampling date, expire date and storage period of meat products:

| Type | Meat product samples | production and expire | Date of sampling | Storage period (months) | Storage temperature | Relative humidity % |
|---|---|---|---|---|---|---|
| BEEF BURGER | (1) | PR 26/06/2016 EX 25/10/2016 | 20/08/2016 | 2 | -14.5° | 33% |
| | (2) | PR 19/06/2016 EX 18/10/2016 | 20/08/2016 | 2 | -14.6° | 33% |
| | (3) | PR 17/06/2016 EX 16/10/2016 | 20/08/2016 | 2 | -14.5° | 33% |
| | (4) | PR 17/04/2016 EX 14/08/2016 | 20/08/2016 | 4 | -15.1° | 33% |
| | (5) | PR 03/08/2016 EX 01/12/2016 | 4/9/2016 | 1 | -12.5° | 69% |
| | (6) | PR 12/06/2016 EX 11/10/2016 | 4/9/2016 | 4 | -12.2° | 69% |
| BEEF KOFTA | (1) | PR 11/02/2016 EX 10/10/2016 | 23/9/2016 | 7 | -11,7° | 25% |
| | (2) | PR 17/08/2016 EX 15/12/2016 | 30/9/2016 | 1 | -18.2 | 50% |
| | (3) | PR 06/09/2016 EX 05/12/2016 | 30/9/2016 | 1 | -4.2 | 24% |
| | (4) | PR 12/08/2016 EX 11/11/2016 | 29/9/2016 | 1 | -19.6 | 37% |
| | (5) | PR 20/08/2016 EX 19/11/2016 | 30/9/2016 | 1 | -26 | 26% |
| | (6) | PR 28/01/2016 EX 27/10/2016 | 30/9/2016 | 8 | -4.2 | 24% |

- Freezers temperature and relative humidity was recorded for each sample using (ISOLAB max-min thermo hygro&clock) freezers thermometer.
- The samples were transported to the food industries' laboratories of the Central Organization of Standardization and Quality Control (C.O.S.Q.C.), Baghdad, Iraq immediately in a thermal isolated box with penalty amount of ice that the temperature never been above (-5 C°).
- All analyses were done in the laboratories of the Central Organization of Standardization and Quality Control (C.O.S.Q.C.) Baghdad, Iraq, which is certified with (ISO 17025) from the UNIDO for many microbiological and chemical analyses.

**Methods:**

**Microbiological examination:**

**Preparation of samples for microbiological examination:**

Ten grams of each sample were homogenized with 90 ml of sterile saline solution (9 g NaCL/ L distilled water). The suspension was shacked by shaker for 5 minutes to give 0.1 dilutions. Then different dilutions (1: $10^{-1}$ to 1: $10^{-6}$) were prepared to be used for microbiological examination.

**Aerobic plate count (APC):**

The aerobic plate count (APC) was performed as described in **(ISO, 2013).**

**Moulds and Yeasts test:**

Moulds and Yeasts test was performed as described in **(IQS, 2006).**

**Total Coliform bacterial count:**

Total coliform bacterial count was performed as described in **(ISO, 2006).**

***Esherichia coli* test:**

*Esherichia coli* test was performed as described in **(IQS, 2006).**

***Staphylococcus aureus* test:**

*Staphylococcus aureus* test was performed as described in **(United States pharmacopeia, 2007).**

***Salmonella* test:**

Salmonella test was performed as described in **(ISO, 2002).**

**Chemical analysis:**

Moisture, crude protein, ether extract and ash contents were determined according to **(A.O.A.C., 2005)**. Total carbohydrates were calculated by difference. Three replication of all these determination were carried out.

**Freshness test:**

**pH value :**

The pH value was determined according to **(Defreitas *et al.*, 1997)**.

**Total volatile nitrogen (TVN):**

Total volatile nitrogen (TVN) was measured according to the method described by **(Pearson, 1984)**.

**Thiobarbituric acid number (TBA):**

Thiobarbituric acid value was determined as described by **(Harold, *et al.*, 1987)** and the results were represented as mg of malonaldhyde /kg sample.

**Physical tests:**

**Water holding capacity (WHC) and plasticity:**

Water holding capacity (WHC) and plasticity were measured according to the method described by **(Soloviev, 1966)**.

**Cooking yield and cooking loss:**

Cooking yield was determined of beef burger and beef cofta samples by calculating the weight difference of samples before and after cooking in boiling water for 10 min according to **(George and Berry, 2000).** Cooking loss was determined according to the method described by **(Mamaghani, 2010)**.

**Shrinkage (%):**

The diameter of burger samples was measured before and after cooking by frying in cotton seed oil for 2 min. at 240 C°. Shrinkage was calculated as percentage of length changed from raw to cooked state according to **(Darweash and Moghazy, 1998)**.

**Thawing loss:**

The thawing loss was done as described by **(Nam *et al.*, 2000)**.

**Sensory evaluation:**

The samples were sensory evaluated by staff members of the Central Organization of Standardization and Quality Control **(C.O.S.Q.C)** to evaluate the taste, aroma, colour, juiciness, tenderness and the overall acceptability of all samples as follows:

- Burger samples were grilled on hot pan using a cotton seed oil for 3.5 minute for each side at 160 °C as described by **(Faheid *et al.*, 1998)**.
- Beef kofta samples sensory evaluated as the producers instructions of preparation.
- Three random digit-codes were given for each sample. Samples served to the panellists in a typical plates at 65 C° as described by **(Bastian, 2015)**.

**Statistical analysis:**

The statistical analysis was carried out using SPSS program with multi-function utility regarding to the experimental design under significance level of 0.05 for the whole results and multiple comparisons were carried out applying LSD according to **(Steel, *et al.*, 1997)**.

**Results and Discussions**

**Microbiology examination of burger samples:**

The six samples of burger were examined to determine the microbiological quality. The obtained data are shown in Table (2) which indicate the Aerobic plate count (APC) was ranged from $1.5x10^2$ to $5.3x10^4$ Cfu/g. However all APC count samples were under the **Egyptian standards (2005).**

**Table 2.** Microbiology examination of burger samples.

| Burger | Aerobic plate count (Cfu/g) | Moulds and Yeasts (Cfu/g) | Coliform group (Cfu/g) | *Esherichia coli* (Cfu/g) | *Staphylococcus Aureus* (Cfu/g) | Salmonella (Cfu/25g) |
|---|---|---|---|---|---|---|
| 1 | $72\times10^2$ | N.D. | N.D. | N.D. | N.D. | N.D. |
| 2 | $3.1x10^3$ | N.D. | $1.5\times10^3$ | N.D. | N.D. | N.D. |
| 3 | $1.5x10^2$ | $2x10^2$ | N.D. | N.D. | $6x10^2$ | N.D. |
| 4 | $3x10^3$ | $1x10^3$ | N.D. | N.D. | $1.3x10^2$ | N.D. |
| 5 | $5.3x10^4$ | $8.2x10^2$ | N.D. | N.D. | N.D. | N.D. |
| 6 | $2.5x10^3$ | $1.7x10^2$ | N.D. | N.D. | N.D. | N.D. |

**N.D.: Not detected*

This results are in agreement with those obtained by **(El-Desouky, 2009 and Saleh, 2010).**

The moulds and yeasts of the beef burger samples were not detected in samples (1) and (2), while it were detected in samples (3), (4), (5) and (6) as: $2x10^2$, $1x10^3$, $8.2x10^2$ and $1.7x10^2$ Cfu/g, respectivly. The exciting of the moulds and yeasts in these samples could came from the ingredients such as seasoning, starch, improbable packaging …etc. **(Tournas *at al.*, 2001)**. These results are in agreement with those obtained by **(Stagnitta *et al.*, 2006)**. The Iraqi food quality standard and the Egyptian food quality standard establishes no regulation for these microorganisms.

The Coliform bacteria count revealed that the all burger samples were free from coliform bacteria

except sample (2) which contained $1.5\times10^3$ Cfu/g. These results are in agreement with those obtained by **(Egyptian standard, 2005 and El-Desouky, 2009).**

The *Esherichia coli* not detected in any of the six burger samples. These results are in agreement with those obtained by **(FSAI, 2013).**

The *Staphylococcus aureus* of the burger detected in samples (3) and (4) which contained $6x10^2$ and $1.3x10^2$ Cfu/g respectively. Where it is not detected in samples (1), (2), (5) and (6). These results are in agreement with those who obtained by **(Egyptian standard, 2005).**

The *Salmonella* of the all six burger samples were not detected. These results are in agreement with those obtained by **(FSAI, 2013 and Egyptian standards, 2005).**

**Chemical composition of burger samples:**

The six samples of burger were chemically analyzed to determine the main chemical composition. The obtained data are shown in Table (3). It could be noticed that the moisture content ranged from 56.80 to 66.91%, which was significantly higher in sample (2), while it was significantly lower in sample (4). Statistical analysis are non-significant difference in moisture content between sample (2) and (5), samples (1) and (3). These results are in agreement with those obtained by **(Heydari, *et al.*, 2015 and El-Desouky, 2009 and Egyptian standard, 2005)**.

The crude protein content of burger samples ranged from 13.52 to 15.92% which was significantly higher in sample (1), while it was significantly lower in sample (6). Statistical analysis are non-significant differences in crude protein content between samples (2), (4) and (5) neither between samples (2), (3) and (4). These results are in agreement with those obtained by **(Small, 2007; El-Desouky, 2009 and Egyptian standard, 2005)**.

**Table 3.** Chemical composition of burger samples (g/100g on wet weight basis).

| Component / Burgers | Moisture | Crude protein | Ether extract | Ash | Total Carbohydrate |
|---|---|---|---|---|---|
| 1 | 63.07 ±0.44$^{b}$ | 15.92 ±0.02$^{a}$ | 10.65 ±0.27$^{e}$ | 2.55 ±0.23$^{a}$ | 7.81 ±0.10b$^{c}$ |
| 2 | 66.91 ±0.25$^{a}$ | 14.43 ±0.01$^{bc}$ | 12.09 ±0.05$^{c}$ | 2.38 ±0.06$^{a}$ | 4.10 ±0.08$^{cd}$ |
| 3 | 62.59 ±0.75$^{b}$ | 14.14 ±0.03$^{c}$ | 17.38 ±0.01$^{b}$ | 1.57 ±0.01$^{b}$ | 4.32 ±0.78$^{e}$ |
| 4 | 56.8 ±0.52$^{d}$ | 14.35 ±0.18$^{bc}$ | 16.13 ±0.07$^{c}$ | 2.72 ±0.19$^{a}$ | 10.00 ±0.45$^{a}$ |
| 5 | 66.22 ±1.12$^{a}$ | 14.73 ±0.03$^{b}$ | 11.81 ±0.05$^{d}$ | 2.63 ±0.09$^{a}$ | 4.61 ±1.08$^{de}$ |
| 6 | 59.27 ±0.15$^{c}$ | 13.52 ±0.29$^{d}$ | 15.55 ±0.84$^{c}$ | 2.47 ±0.07$^{a}$ | 9.19 ±0.55$^{ab}$ |

a,b&c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.

With regard to ether extract content of the burger samples, it could be observed that the ether extract ranged from 10.65 to 17.38% which was significantly higher in sample (3), while it was significantly lower in sample (1) statistical analysis are non-significantly differences in ether extract between samples (2), (4) and (6) which contained 12.09, 16.13 and 15.55% from ether extract respectively. These result are in agreement with reported by **(Selani *et al*., 2016 and Egyptian standard, 2005)**.

On the other total ash content of burger ranged from 1.57 to 2.72%, which was significantly higher in sample (4), while it was significantly lower in sample (3). Statistical analysis are non-significant differences in ash content between all samples, which contained 2.55, 2.38, 2.72, 2.63 and 2.47% from total ash, respectively. These results are in agreement with those obtained by **(El-Desouky, 2009 and Heydari *et al.*, 2015)**.

Finally the total carbohydrates ranged from 4.10% to 10.00%. The highest significantly values of total carbohydrate were in sample (4) which contained 10.00%, while the lowest significant value was in sample (2), which contained 4.10%. The total carbohydrates content could came from non-meat ingredients like starch, ground bread, onion ...etc. which they allowable by the Iraqi meat products standard **(IQS 1580, 1990)**. These results is in agreement with those recorded by (**El-Desouky, 2009 and Egyptian standard, 2005).**

**Freshness properties of burger samples:**

The six samples of burger were analyzed to determine the freshness properties. The obtained data are shown in table (4). It could be noticed that the pH value ranged from 5.97 to 6.56 which was significantly higher sample (4) while it was significantly lower in sample (1). Statistical analysis are non-significant difference in pH value between

samples (3) and (4) and samples (5) and (6). These results are in agreement with those obtained by **(Shariati-Ievari, 2013; Angiolillo *et al*., 2015; Nicholson, 2013 and El-Desouky, 2009).**

**Table 4.** Some freshness properties of burger samples.

| Component / Burgers | pH value | TVN (mg/100g) | TBA (mg/kg) |
|---|---|---|---|
| 1 | 5.97 ±0.02$^{c}$ | 22.70 ±0.20$^{b}$ | 2.39 ±0.02$^{b}$ |
| 2 | 6.45 ±0.00$^{ab}$ | 18.43 ±0.23$^{de}$ | 0.70 ±0.00$^{c}$ |
| 3 | 6.48 ±0.08$^{a}$ | 17.59 ±0.41$^{e}$ | 0.30 ±0.00$^{e}$ |
| 4 | 6.56 ±0.01$^{a}$ | 20.13 ±0.13$^{c}$ | 0.32 ±0.00$^{e}$ |
| 5 | 6.35 ±0.00$^{b}$ | 18.80 ±0.42$^{d}$ | 0.46 ±0.03$^{d}$ |
| 6 | 6.36 ±0.02$^{b}$ | 23.86 ±0.02$^{a}$ | 3.67 ±0.05$^{a}$ |

a,b&c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.

While the TVN content of beef burger samples ranged from 17.59 to 23.86 mg/100g which was significantly higher in sample (6), while it was significantly lower in sample (3). Statistical analysis appear significantly differences in TVN content between all samples. Samples (1), (4) and (6) which they have a TVN value higher than 20 mg/100g, that could came from improper freezing temperature or using high TVN value in raw meat **(Food Standard Agency, 2016)**. These results are in agreement with those obtained by **(Saleh, 2010).**

On the other hand the TBA content ranged from 0.30 to 3.67 mg/kg which was significantly higher in sample (6), while it was significantly lower in sample (3). Statistical analysis are non-significant differences in TBA content between samples (3) and (4). The TBA value was exceeded to 1 mg/kg in samples (1) and (6) and that could came from the high lipids content and improper freezing conditions which can increase lipid oxidation **(Brewer, 2011)**.These results are in agreement with those obtained by **(Bond, 1996)**.

**Physical properties of burger samples:**

The obtained data are shown in Table (5) noticed that the WHC ranged from 1.36 to 7.96 which was significantly higher in sample (3), while it was significantly lower in sample (2). Statistical analysis are significant difference in WHC between samples (1) and (6) and between samples (2), (4) and (5) and non-significant between samples (4) and (5). These results are in agreement with those obtained by **(AL-Qhtaney, 2008 and El-Desouky, 2009)**.

**Table 5.** Some physical properties of burger samples.

| Properties / Burgers | WHC ($cm^2$/0.3 g) | Plasticity ($cm^2$/0.3 g) | Cooking yield (%) | Cooking loss (%) | Shrinkage (%) | Thawing loss (%) |
|---|---|---|---|---|---|---|
| 1 | 5.53 ±1.05$^{b}$ | 6.20 ±1.71$^{a}$ | 81.00 ±0.00$^{d}$ | 19.00 ±0.00$^{a}$ | 20.00 ±0.00$^{b}$ | 8.82 ±0.28$^{c}$ |
| 2 | 1.36 ±0.18$^{d}$ | 1.90 ±1.53$^{b}$ | 98.00 ±00.00$^{a}$ | 2.00 ±0.00$^{d}$ | 10.52 ±0.00$^{d}$ | 13.79 ±0.43$^{b}$ |
| 3 | 7.96 ±0.39$^{a}$ | 2.46 ±0.20$^{b}$ | 82.00 ±0.00$^{d}$ | 18.00 ±0.00$^{a}$ | 17.19 ±1.41$^{bc}$ | 22.36 ±0.42$^{a}$ |
| 4 | 2.33 ±0.26$^{cd}$ | 1.95 ±0.27$^{b}$ | 98.00 ±0.00$^{a}$ | 2.00 ±0.00$^{d}$ | 27.01 ±2.40$^{a}$ | 16.74 ±0.19$^{b}$ |
| 5 | 3.08 ±0.14$^{cd}$ | 2.16 ±0.16$^{b}$ | 92.00 ±1.53$^{b}$ | 8.00 ±1.53$^{c}$ | 20.00 ±0.00$^{b}$ | 17.44 ±3.29$^{b}$ |
| 6 | 4.00 ±0.70$^{bc}$ | 2.74 ±0.42$^{b}$ | 88.00 ±0.00$^{c}$ | 12.00 ±0.00$^{b}$ | 15.78 ±0.00$^{c}$ | 22.99 ±0.20$^{a}$ |

a,b&c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.

While the plasticity of burger samples ranged from 1.90 to 6.20 which was significantly higher in sample (1), while it was significantly lower in sample (2). Statistical analysis are non-significant differences in the plasticity between samples (2), (3), (4), (5) and (6). These results are in agreement with those obtained by **(AL-Qhtaney, 2008 and El-Desouky, 2009)**.

The cooking yield percentage of burger samples ranged from 81.00 to 98.00% which was significantly higher in samples (2) and (4), while it was significantly lower in sample (1). Statistical analysis are non-significant differences in cooking yield between samples (1) and (3) and between samples (2) and (4). These results are in agreement with those obtained by **(Bahlol and Abd El-Aleem, 2004; El-Desouky, 2009; Abu-Almaaly and Al-Temimi, 2011)**.

The cooking loss percentage of burger samples ranged from 2.00 to 19.00 which was significantly higher in sample (1), while it was significantly lower in sample (2) and (4). Statistical analysis are non-significant difference in cooking loss between samples (1) and (3) and between samples (2) and (4). These results are in agreement with those obtained by **(Bahlol and Abd El-Aleem, 2004 and El-Desouky, 2009)**.

The shrinkage percentage of burger samples ranged from 10.52 to 27.01% which was significantly higher in sample (4), while it was significantly lower in sample (2). Statistical analysis are non-significant difference in shrinkage between samples (1) and (5) and between samples (3) and (6). These results are in agreement with those obtained by **(Shariati-Ievari, 2013; Angiolillo *et al*., 2015; Nicholson, 2013; El-Desouky, 2009; Abu-Almaaly and Al-Temimi, 2011).**

The thawing loss percentage of burger samples ranged from 8.82 to 22.99 % which was significantly higher in sample (6), while it was significantly lower in sample (1). Statistical analysis are non-significant differences in thawing loss between samples (2), (4) and (5) and significantly between samples (2), (3), (4), (5) and (6). These results are in agreement with those obtained by **(Nicholson, 2013; Abu-Almaaly and Al-Temimi, 2011)**.

**Sensory evaluation of burger samples:**

The six samples of burger were evaluated to determine their sensory properties. The obtained data are shown in Table (6). It could be noticed that the color character ranged from 12.25 to 15.33 which was higher in sample (4), while it was lower in sample (5). Statistical analysis are non-significant difference in color between all samples. These results are in agreement with those obtained by **(AL-Qhtaney, 2008; El-Desouky, 2009 and Nicholson, 2013)**.

The taste character ranged from 10.08 to 15.17 which was significantly higher in samples (2), while it was significantly lower in sample (1). Statistical analysis are non-significant differences in taste between samples (1), (4) and (6) neither between samples (2), (3), (4), (5) and (6). These results are in agreement with those obtained by **(AL-Qhtaney, 2008; El-Desouky, 2009 and Nicholson, 2013)**.

The smell character ranged from 11.00 to 14.33 which was higher in sample (2) and (4), while it was lower in sample (1). Statistical analysis are non-significant difference in smell between all samples. These results are in agreement with those obtained by **(Nicholson, 2013; AL-Qhtaney, 2008).**

**Table 6.** Sensory evaluation of burger samples.

| Atributes / Burger samples | Color (20) | Taste (20) | Smell (20) | Tenderness (20) | Juiciness (20) | Overall acceptability (100) |
|---|---|---|---|---|---|---|
| 1 | 15.00 ±1.07$^{a}$ | 10.08 ±1.48$^{b}$ | 11.00 ±1.51$^{a}$ | 12.25 ±1.24$^{b}$ | 12.92 ±0.97$^{a}$ | 61.25 ±4.65$^{b}$ |
| 2 | 14.75 ±1.08$^{a}$ | 15.17 ±0.98$^{a}$ | 14.33 ±0.93$^{a}$ | 14.33 ±1.01$^{ab}$ | 13.25 ±0.75$^{a}$ | 69.17 ±4.30$^{ab}$ |
| 3 | 12.75 ±1.09$^{a}$ | 13.50 ±0.98$^{a}$ | 14.25 ±0.87$^{a}$ | 16.42 ±0.84$^{a}$ | 15.08 ±0.86$^{a}$ | 68.67 ±3.55$^{ab}$ |
| 4 | 15.33 ±0.74$^{a}$ | 13.08 ±0.98$^{ab}$ | 14.33 ±0.76$^{a}$ | 16.42 ±0.58$^{a}$ | 14.08 ±0.76$^{a}$ | 68.75 ±3.43$^{ab}$ |
| 5 | 12.25 ±1.35$^{a}$ | 13.83 ±1.15$^{a}$ | 14.25 ±1.35$^{a}$ | 17.08 ±0.90$^{a}$ | 15.00 ±0.93$^{a}$ | 72.41 ±4.88$^{a}$ |
| 6 | 12.67 ±1.05$^{a}$ | 12.08 ±0.81$^{ab}$ | 13.58 ±0.80$^{a}$ | 14.67 ±1.05$^{ab}$ | 13.58 ±0.97$^{a}$ | 62.83 ±3.69$^{ab}$ |

a,b&c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.

The tenderness character ranged from 12.25 to 17.08 which was significantly higher in sample (5), while it was significantly lower in sample (1). Statistical analysis are non-significant differences in tenderness between samples (2) and (6) and between samples (3), (4), and (5). These results are in agreement with those obtained by **(Abu-Almaaly and Al-Temimi, 2011 and Angiolillo *et al*., 2015).**

The juiciness character ranged from 12.92 to 15.08 which was higher in sample (3), while it was lower in sample (1). Statistical analysis are non-significant difference in tenderness between all samples. These results are in agreement with those obtained by **(El-Desouky, 2009; Abu-Almaaly and Al-Temimi, 2011 and Angiolillo *et al*., 2015).**

Finally the overall acceptability ranged from 61.15 to 72.41 which was significantly higher in sample (5), while it was significantly lower in sample (1). Statistical analysis are non-significant differences in overall acceptability between samples (2), (3), (4) and (6). These results are in agreement with those obtained by **(El-Desouky, 2009; Abu-Almaaly and Al-Temimi, 2011; Nicholson, 2013 and Angiolillo *et al*., 2015).**

**Microbiological examination of kofta samples:**

The six samples of kofta were examined to determine the microbiological quality. The obtained data are shown in Table (7) which indicated that the aerobic plate count (APC) ranged from $3.6\times10^2$ to $4.6\times10^5$ cfu/g which was higher in sample (1), while it was lower in samples (5) and (6). This results are in agreement with those obtained by **(Daglioglu *et al*., 2005).**

**Table 7.** Microbiological examination of kofta samples.

| Kofta samples | Aerobic plate count (cfu/g) | Moulds and Yeasts (cfu/g) | Coliform group (cfu/g) | *Echerichia coli* (cfu/g) | *Staphylococcus Aureus* (cfu/g) | Salmonella (cfu/25g) |
|---|---|---|---|---|---|---|
| 1 | $4.6\times10^5$ | $1.2\times10^3$ | N.D. | N.D. | $5\times10^2$ | N.D. |
| 2 | $8\times10^3$ | $2.3\times10^2$ | $1\times10^4$ | $8.3\times10^3$ | $3.3\times10^3$ | N.D. |
| 3 | $1.6\times10^3$ | $6.6\times10^2$ | N.D. | N.D. | N.D. | N.D. |
| 4 | $1.7\times10^4$ | $1.3\times10^2$ | N.D. | N.D. | N.D. | N.D. |
| 5 | $3.6\times10^2$ | $1.8\times10^2$ | N.D. | N.D. | N.D. | N.D. |
| 6 | $3.6\times10^2$ | $9.3\times10^2$ | N.D. | N.D. | N.D. | N.D. |

**N.D.: Not detected*

The moulds and yeasts of all kofta samples was ranged from $1.3\times10^2$ to $1.2\times10^3$ cfu/g which was higher in sample (1), while it was lower in sample (4). These results are in agreement with those obtained by **(Daglioglu *et al*., 2005).**

The Coliform group bacteria count revealed that all kofta samples are clear of coliform bacteria except sample (2) which contained $1\times10^4$ cfu/g. These results are in agreement with those obtained by **(Daglioglu *et al*., 2005).**

The *Esherichia coli* not detected in any of kofta samples except sample (2) which has been $8.3\times10^3$ Cfu/g. These results are in agreement with those obtained by **(Daglioglu *et al*., 2005 and Hassanin *et al*., 2014)**.

The *staphylococcus aureus* of kofta samples not detected in samples (3), (4), (5) and (6). Where it is detected for samples (1) and (2) which contained $5\times10^2$ and $3.3\times10^3$ cfu/g, respectively. These results are in agreement with those obtained by **(Daglioglu *et al*., 2005).**

The Salmonella of the all kofta samples revealed that there is no positive samples are detected. These results are in agreement with those obtained by **(Bhilegaonkar, 2009 and Hassanin *et al*., 2014)**.

**Chemical composition of kofta samples:**

The six samples of kofta were chemically analyzed to determine the main chemical composition. The obtained data are shown in table (8). It could be noticed that the moisture content ranged from 53.69 to 66.10% which was significantly higher in sample (5), while it was significantly lower in sample (2). Statistical analysis are non-significant difference in moisture content between sample (4) and (5). These results are in agreement with those obtained by **(Edris *et al*., 2012)**.

The crude protein content of kofta samples ranged from 11.37 to 17.47% which was significantly higher in sample (4), while it was significantly lower in sample (3). Statistical analysis are non-significant differences in crude protein content between samples (1) and (6), and between samples (3) and (5). These results are in agreement with those obtained by (**Al-Kutby, 2012)**.

With regard to ether extract content of the kofta samples, it could be observed that the ether extract ranged from 8.61 to 22.68% which was significantly higher in sample (6), while it was significantly lower in sample (4). Statistical analysis are non-significantly differences in ether extract between samples (1) and (2) and between samples (3) and (5). These result are in agreement with the Iraqi national standard **(IQS, 1990)**.

Ash content of kofta ranged from 1.32 to 3.15% which was significantly higher in sample (2), while it was significantly lower in sample (1). Statistical analysis are non-significant differences in ash content between all samples. These result are in agreement with those obtained by **(Al-Kutby, 2012).**

**Table 8.** Chemical composition of kofta samples (g/100g on wet weight basis).

| Components / Kofta Samples | Moisture | Crude protein | Ether extract | Ash | Total Carbohydrate |
|---|---|---|---|---|---|
| 1 | 58.96 ±0.07$^{c}$ | 14.34 ±0.26$^{abc}$ | 16.34 ±0.18$^{b}$ | 1.32 ±0.03$^{e}$ | 9.04 ±0.51$^{b}$ |
| 2 | 53.69 ±0.37$^{e}$ | 16.05 ±3.34$^{ab}$ | 16.60 ±0.12$^{b}$ | 3.15 ±0.18$^{a}$ | 10.51 ±0.31$^{c}$ |
| 3 | 59.90 ±0.01$^{b}$ | 11.37 ±0.00$^{c}$ | 12.53 ±0.02$^{c}$ | 1.90 ±0.01c | 14.30 ±0.01$^{a}$ |
| 4 | 65.56 ±0.33$^{a}$ | 17.47 ±0.13$^{a}$ | 8.61 ±0.02$^{d}$ | 1.54 ±0.10$^{de}$ | 6.82 ±0.34$^{cd}$ |
| 5 | 66.10 ±0.33$^{a}$ | 12.74 ±0.06b$^{c}$ | 12.47 ±0.05$^{c}$ | 2.67 ±0.05$^{b}$ | 6.02 ±0.22$^{d}$ |
| 6 | 57.84 ±0.37$^{d}$ | 14.61 ±0.00$^{abc}$ | 22.68 ±0.02$^{a}$ | 1.66 ±0.05$^{cd}$ | 3.21 ±0.31$^{e}$ |

a,b&c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.

Finally the highest significantly values of total carbohydrate was in sample (3) which contained 14.30%, while the lowest significant value was in sample (6), which contained 3.21%. The total carbohydrates content could came from non-meat ingredients like starch, ground bread, onion ...etc. which they allowable by the Iraqi meat products standard **(IQS, 1990)**.

**Some freshness properties of kofta samples:**

The six samples of kofta were analyzed to determine the some freshness properties. The obtained data are shown in Table (9). It could be noticed that the pH value ranged from 6.15 to 6.71 which was significantly higher in sample (5), while it was significantly lower in samples (1) and (6). Statistical analysis are non-significant difference in pH value between sample (1) and (6). These results are in agreement with those obtained by **(Edris *et al*., 2012).**

The TVN content of beef kofta samples ranged from 11.20 to 23.33 mg/100g which was significantly higher in sample (4), while it was significantly lower in sample (3). Statistical analysis are non-significant differences in TVN content between samples (1) and (2). Sample (4) which has a TVN value higher than 20 mg/100g, that value could came from improper freezing temperature or using high TVN value in raw meat **(Food Standard Agency, 2016).**

**Table 9.** Some freshness properties of kofta samples.

| Parameters / Kofta samples | pH value | TVN (mg/100g) | TBA (mg/kg) |
|---|---|---|---|
| 1 | 6.15 ±0.00$^{e}$ | 18.20 ±0.00$^{b}$ | 0.99 ±0.02$^{c}$ |
| 2 | 6.22 ±0.00$^{d}$ | 18.20 ±0.00$^{b}$ | 1.28 ±0.02$^{a}$ |
| 3 | 6.48 ±0.02$^{b}$ | 11.20 ±0.00$^{e}$ | 0.60 ±0.00$^{f}$ |
| 4 | 6.33 ±0.00$^{c}$ | 23.33 ±0.23$^{a}$ | 0.88 ±0.00$^{d}$ |
| 5 | 6.71 ±0.01$^{a}$ | 15.17 ±0.23$^{c}$ | 0.73 ±0.03$^{e}$ |
| 6 | 6.15 ±0.00$^{e}$ | 12.37 ±0.23$^{d}$ | 1.06 ±0.00$^{b}$ |

a,b&c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.

The TBA content of kofta samples ranged from 0.60 to 1.28 mg/kg which was significantly higher in sample (2), while it was significantly lower in sample (3). The TBA value was exceeded to 1 mg/kg in samples (2) and (6), that could came from the high lipids content and improper freezing conditions which can increase lipid oxidation **(Brewer, 2011)**. These results are in agreement with those obtained by **(Al-Kutby, 2012).**

**Some physical properties of kofta samples:**

The six samples of kofta were analyzed to determine the physical properties. The obtained data are shown in Table (10). It could be noticed that the WHC ranged from 1.46 to 6.13 $cm^2$/0.3 g which was significantly higher in sample (4), while it was significantly lower in sample (2). Statistical analysis are non-significant difference in WHC between samples (1), (3) and (5) and between samples (4) and (6).

The plasticity of kofta samples ranged from 1.16 to 5.56 % which was significantly higher in sample (1), while it was significantly lower in sample (2). Statistical analysis are non-significant differences in plasticity between samples (3) and (4) and significantly differences between samples (1), (2), (5) and (6).

The cooking yield percentage ranged from 64.12 to 91.00% which was significantly higher in samples (5), while it was significantly lower in sample (6). Statistical analysis are non-significant differences in cooking yield between samples (1) and (3) neither between samples (2), (4) and (5). These results are in agreement with those obtained by **(Pandey *et al.*, 2014)**.

The cooking loss percentage of kofta samples ranged from 9.00 to 35.88 which was significantly higher in sample (6), while it was significantly lower in sample (5). Statistical analysis are non-significant difference in cooking loss between samples (2), (4) and (5) and between samples (1) and (3). These results are in agreement with those obtained by **(Pandey *et al.*, 2014)**.

**Table 10.** Some physical properties of kofta samples.

| Kofta samples \ Parameters | WHC ($cm^2$/0.3 g) | Plasticity ($cm^2$/0.3 g) | Cooking yield (%) | Cooking loss (%) | Thawing loss (%) |
|---|---|---|---|---|---|
| 1 | 3.43 ±0.61$^{b}$ | 5.56 ±0.72$^{a}$ | 72.33 ±1.45$^{ab}$ | 27.67 ±1.45$^{ab}$ | 25.55 ±0.89$^{b}$ |
| 2 | 1.46 ±0.33$^{c}$ | 1.16 ±0.08$^{d}$ | 87.33 ±3.48$^{a}$ | 12.67 ±3.48$^{b}$ | 21.92 ±0.05$^{c}$ |
| 3 | 2.76 ±0.40$^{b}$ | 2.36 ±0.44$^{cd}$ | 78.33 ±15.68$^{ab}$ | 21.67 ±15.68$^{ab}$ | 34.51 ±0.03$^{a}$ |
| 4 | 6.13 ±0.63$^{a}$ | 1.96 ±0.27$^{cd}$ | 86.33 ±0.33$^{a}$ | 13.67 ±0.33$^{b}$ | 32.73 ±2.08$^{a}$ |
| 5 | 3.93 ±0.33$^{b}$ | 3.16 ±0.14$^{bc}$ | 91.00 ±0.58$^{a}$ | 9.00 ±0.58$^{b}$ | 19.61 ±0.47$^{c}$ |
| 6 | 5.61 ±0.04$^{a}$ | 4.23 ±0.13$^{b}$ | 64.12 ±0.09$^{b}$ | 35.88 ±0.09$^{a}$ | 19.18 ±0.03$^{c}$ |

a,b&c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.

The thawing percentage of kofta samples ranged from 19.18 to 34.51 % which was significantly higher in sample (3), while it was significantly lower in sample (6). Statistical analysis are non-significant differences in thawing loss between samples (2), (5) and (6) and between samples (3) and (4).

**Sensory properties of kofta samples:**

The six samples of kofta were evaluated to determine their sensory properties. The obtained data are shown in Table (11). It could be noticed that the color character ranged from 12.25 to 15.83 which was significantly higher in sample (5), while it was significantly lower in sample (6). Statistical analysis are non-significant difference in color between sample (1), (2), (3) and (4) and significant differences between samples (3) and (6). These results are in agreement with those obtained by **(Al-Kutby, 2012).**

The taste character ranged from 11.00 to 15.00 which was significantly higher in samples (3), while it was significantly lower in sample (6). Statistical analysis are non-significant differences in taste between samples (1), (2), (4) and (5) and significant differences between samples (3) and (6). These results are in agreement with those obtained by **(Al-Kutby, 2012)**.

The smell character of kofta samples ranged from 10.83 to 15.42 which was significantly higher sample (5), while it was significantly lower in sample (6). Statistical analysis are non-significant difference in smell between samples (1), (2) and (3) and between samples (4) and (6). These results are in agreement with those obtained by **(Al-Kutby, 2012).**

The tenderness character of kofta samples ranged from 11.67 to 15.42 which was significantly higher in sample (3), while it was significantly lower in sample (1). Statistical analysis are non-significant differences

in tenderness between samples (1), (2) and (3) and between samples (3) and (5).

**Table 11.** Sensory properties of kofta samples.

| Kofta samples | Color | Taste | Smell | Tenderness | Juiciness | Overall acceptability |
|---|---|---|---|---|---|---|
| 1 | 14.33 ±0.99$^{ab}$ | 12.67 ±1.14$^{ab}$ | 13.00 ±1.36$^{ab}$ | 13.42 ±1.16$^{ab}$ | 12.92 ±1.10$^{a}$ | 60.58 ±5.57$^{ab}$ |
| 2 | 13.17 ±0.82$^{ab}$ | 12.42 ±0.81$^{ab}$ | 13.42 ±0.92$^{ab}$ | 13.17 ±0.84$^{ab}$ | 12.08 ±0.96$^{a}$ | 59.00 ±5.46$^{ab}$ |
| 3 | 14.83 ±0.80$^{ab}$ | 15.00 ±0.78$^{a}$ | 14.08 ±1.05$^{ab}$ | 15.42 ±0.77$^{a}$ | 14.08 ±1.20$^{a}$ | 70.33 ±4.63$^{a}$ |
| 4 | 15.00 ±0.80$^{ab}$ | 13.08 ±1.06$^{ab}$ | 14.83 ±0.86$^{a}$ | 14.75 ±0.87$^{ab}$ | 14.17 ±0.87$^{a}$ | 68.25 ±5.39$^{a}$ |
| 5 | 15.83 ±0.81$^{a}$ | 14.00 ±0.95$^{ab}$ | 15.25 ±1.17$^{a}$ | 15.08 ±1.01$^{a}$ | 14.17 ±0.99$^{a}$ | 75.00 ±4.04$^{a}$ |
| 6 | 12.25 ±1.16$^{b}$ | 11.00 ±1.39$^{b}$ | 10.83 ±1.52$^{b}$ | 11.67 ±1.54$^{b}$ | 12.75 ±1.40$^{a}$ | 48.25 ±7.59$^{b}$ |

a,b&c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.

The juiciness character ranged from 12.08 to 14.17 which was higher in sample (4) and (5), while it was lower in sample (2). Statistical analysis are non-significant difference in smell between all samples.

The overall acceptability of kofta samples ranged from 48.25 to 75.00 which was significantly higher in sample (5), while it was significantly lower in sample (6). Statistical analysis are non-significant differences in overall acceptability between samples (1) and (2) and between samples (3), (4) and (5). These results are in agreement with those obtained by **(Al-Kutby, 2012).**

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# دراسة عن مؤشرات الجودة و السلامة لبعض منتجات اللحوم

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**الملخص**

الهدف الرئيسى لهذا البحث هو تقييم ظروف التخزين، الجودة، السلامة لمنتجات اللحوم ومدى مطابقة المنتجات لفترة الصلاحية المسجل عليها. تم جمع اثني عشر منتجاً للحوم (6 عينات من برجر اللحم البقرى و 6 عينات من كفتة اللحم البقرى) من السوق المحلي في مدينة بغداد، جمهورية العراق. تم قياس معدل درجة حرارة التخزين والرطوبة النسبية لمدة 24 ساعة داخل مجمدات بيع هذه المنتجات وتم نقلها مباشرة تحت ظروف معقمة باستخدام صندوق عازل للحرارة حاوى على كمية وافرة من الثلج وتم اجراء التحاليل والاختبارات الميكروبيولوجية، الكيميائية، الطبيعية والحسية عليها. اظهرت النتائج المتحصل عليها ان افضل العينات من عينات برجر اللحم البقرى الستة من ناحية الاختبارات الميكروبيولوجية كانت النيتروجين المتطاير الكلى وكانت ايضا فى نسبة البروتين الخام، وكانت العينة رقم (3) الأدنى في قيمة العينة رقم (1)، والتي كانت ايضا الأعلى الأدنى في قيمة لحامض الثيوبربتيوريك، وكانت أفضل عينة في التقييم الحسي العينة رقم (5). وبالنسبة لعينات الكفتة الستة اظهرت النتائج ان للنايتروجين أفضل عينة في الإختبارات الميكروبيولوجية كانت العينة رقم (5)، وكانت العينة رقم (4) الأعلى في نسبة البروتين الخام وأدنى قيمة المتطاير الكلى لعينات الكفتة البقرى في العينة رقم (3)، وكانت العينة رقم (5) أدنى قيمة في نسبة حامض الثيوبربيتيوريك والأفضل في التقييم الحسي. وأظهرت النتائج المتحصل عليها أن ظروف التخزين كانت غير جيدة لعدد من العينات بالإضافة لوجود تلوث لبعض العينات ملوثة ببكتريا الفساد الغذائي وعينات أخرى كانت حاوية محتوية على البكتريا المسببة للأمراض المنقولة بالأغذية في أسواق منتجات اللحوم المحلية العراقية.