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Original Research Article

# Comparison of the Nutritive Values of Different Types of Evaporated Milk Available in Local Marketing in Benghazi City, Libya

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**Abstract:** Milk is a primary source of nutrition for all mammals. Evaporated milk is available in cans and it is gaining popularity worldwide due to the long shelf life it enjoys. Evaporated milk does not require refrigeration if the can is not opened. Removing of about 60% of water from fresh milk produces evaporated milk. This research has aimed to compare the nutritive values of different types of evaporated milk available in the local market in Benghazi city; Libya. The milk brands were coded from M1 to M17. Seventeen brands of evaporated milk marked in Benghazi were analysed to evaluate the proximate values of total energy, moisture, ash, fat, protein, lactose, solid non-fat, acidity and PH. The analysed results were compared to labeled values by the producers which found to be in close agreement. The analysed values were also being found in compliance with Libyan standers and codex standers.
**Keywords:** Evaporated, Milk, Nutritive Values, Labels, Codex.

## INTRODUCTION

Milk is a white liquid produced by the mammary glands of mammals. Milk is an excellent source of vitamins such as vitamin C; and minerals, particularly calcium [1, 2]. The composition of milk differs widely among species and producers. Factors such as the type of protein, fat and carbohydrates, the content of different minerals and vitamins play an essential role on milk types and differences [3]. Evaporated milk is available in cans and it is gaining popularity worldwide due to the long shelf life it enjoys. It has a longer life up to fifteen months than fresh milk and can be stored for practically any length of time at a temperature of 0-15 [4-7].

It does not require refrigeration if the can is not opened. Once the can is opened, it has to be kept in refrigerator. Evaporated milk is quite thicker than fresh milk. Exposure of fresh milk to high heat removes water from milk. Removal of about 60% of water from fresh milk produces evaporated milk. Evaporated milk is also known as dehydrated milk [4]. Evaporated milk can be made from both whole milk and skim milk. In either case, the milk is homogenized and then the water is removed by gently heating. The evaporated milk product is heated to kill any bacteria in. Thus evaporated milk is actually sterile, which, combined with the fact that it is stored in airtight cans, gives it an extremely long shelf life [3]. The evaporation process also concentrates the nutrients and the energy content of the evaporated milk [5]. Evaporated milk differs from sweetened condensed milk, which contains added sugar. Sweetened condensed milk requires less processing since the added sugar inhibits bacterial growth [6]. According to the United States Code of Federal Regulations, evaporated milk is the liquid food obtained by partial removal of water [7]. It contains not less than 6.5 percent by weight of milk fat, not less than 16.5 percent by weight of milk solids not fat, and not less than 23 percent by weight of total milk solids. It is sealed in a container and so processed by heat, either before or after sealing, as to prevent spoilage. Evaporated milk usually contains added vitamin D [7-9]. For many developing countries, evaporated milk is commonly consumed for its nutritional value [2, 7, 10]. In developed countries, it is often used as an ingredient in various food preparations. Different food industries such as infant food producers, confectioneries, bakeries and dairies use evaporated milk as a concentrated source of milk in many of their finished products. Evaporated whole milk is purchased primarily by the confectionery industry while evaporated skimmed milk

is commonly used as a source of milk solids in dairy applications and in the manufacture of ice cream, frozen yogurt and other frozen desserts. It can be heated easily (without precipitation of the proteins) to prepare sauces and to thicken puddings [2]. Worldwide, the milk industry is subject to stringent regional and national regulations regarding the prevention of bacterial growth and the composition of solids and fats.

According to the United States Food and Drug Administration (FDA), evaporated milk must contain at least 6.5% by weight of milk fat, at least 16.5% by weight of milk solids that are not fat, and at least 23% by weight of total milk solids. The evaporated milk must also contain 25 International Units (IUs) of vitamin D [11, 12]. The milk is taste-tested for freshness before it leaves the dairy farm and again when it arrives at the processing plants. Once the milk arrives at the plant, it is not touched by the workers, making its journey from raw milk to evaporate strictly through hygienic pipes, vats, and other machinery.

One cup of evaporated milk provides a variety of nutrients. Evaporated milk health benefits include about 19 g of fats, which fulfills 29 percent of the daily fat requirement. Out of the total fat, 11.5g is saturated fat [13, 14]. Evaporated milk usually has 338 calories and 78mg of cholesterol. One cup of evaporated milk usually has 17g of proteins [4]. Evaporated milk provides vitamins such as vitamin A and vitamin C. Evaporated milk fulfills 8 percent of the daily vitamin C requirement and 12 percent of the daily vitamin A requirement [2.4, 12-14].

**Evaporated milk is a rich source of calcium and fulfills 66 percent of the daily requirement.**

Evaporated milk is widely consumed food product in Libyan community. Evaporated milk is represented an essential source of nutrients for many Libyan families for all age groups. Furthermore, evaporated milk enters in many traditional meals ingredients as well as in bakery and confectionary. This wide range of consumption and usage makes evaporated milk nutritional values and characteristics are worthwhile to study. Shortage in research about evaporated milk nutritive values in Benghazi city and Libya as well make this research important to carry out. The aim of this study was to compare the analysed results with labelled values by the producers to investigate any discrepancies between both values. The study has aimed also to compare the results with those reported by Codex standards and Libyan standard for evaporated milk [12-15].

## MATERIAL AND METHODS

This study is a cross-sectional study which was carried out from 1$^{th}$ April 2016 to 15$^{th}$ December 2016 on different brands of evaporated milk which available in local marketing in Benghazi city. The exclusion criterion for involved evaporated milk in the present study was all condensed and/ or sweetened, flavoured brands as well as types which include fats from plants sources. The cans internal and external conditions were checked out thoroughly to observe the presence of any kind of abnormalities. All samples were found to be in good conditions and approximately within the same range of period of validity. Based on these criterions a total of 21 types of evaporated milk were available and accessible in the local markets in the period between 1$^{th}$ April 2016 to 20$^{th}$ April 2016 (Period of data collection) have been included in this study. Out of these 21 types, 4 types were excluded from the study because they have not met the inclusion criteria. A total of 17 types which met the inclusion criteria were finally included in the study giving a response rate of 81%.

### Ethics in food analysis research

Informed consent was obtained from the markets administration who was also assured of the confidentiality of the information collected to obtain the maximum possible cooperation to conduct the study.

### Methods

The included evaporated milk samples were analysed at the food analysis laboratories of Nutrition department, Faculty of Public Health – Benghazi University; to determine the proximate composition in term of moisture, ash, PH, fat, protein, lactose solid, non-fat (SNF), freezing point (FPP) and acidity. All brands of milk were assigned the fictitious numbers from M1 to M17 to keep the secrecy of the original samples and to avoid any bias from the research team. The percentage of protein, fat, lactose, FPP and SNF were determined by using automatic milk analyser "Lactostar". PH was determines by using digital PH meter, while moisture and total solids were determined by drying the milk in drying oven at 100 C0. Ash was determined by heating samples in muffle furnace at 580 C0. Acidity was determined by direct titration [18].

### Experiments

### Determination of PH

At room temperature, the PH meter's electrodes were immersed in buffer solution of pH 7, and allow 10 to 30 seconds for equilibrium. After that an adjustment of the calibration control until meter was done and the PH reading of the buffer solution at the used temperature was taken. The following step is

returning the control switch to standby and removing the electrodes, washing with distal water and wiping dry with tissue. Finally, immersing the electrodes in the milk solution to be measured, switching to PH position and reading the PH value on the meter [19].

**Determination of Moisture:**

The sample was placed in a flask which is connected with a reflux condenser equipped with a distilled trap. Consequently, the sample was covered with a suitable solvent and the trap is filled with the solvent. The flask was heated and the vapors of water and solvent were condensed by the condenser and drop into the trap. The lighter solvent flows over into the flask but water was captured. If the trap is calibrated the amount of water distilled out of the sample can be read directly. The used solvent was immiscible with water. Toluene was the most commonly used solvent.

**Procedure and Calculation s (Drying Method)**

Weight of empty dish X gm
Weight of dish plus sample Y gm
Weight of dish plus dried sample Z gm

Percentage of moisture = $\frac{Y- Z}{Y-X} * 100$ [18]

**Determination of Ash and mineral matter**

This process involves weighing of 5 g of the sample in to a silica (or platinum) dish, which has previously been ignited and cooled before weighing. Then ignite dish and contents, first gently over a low flame at 500 $C^0$. The ashing process can be completed if the particle broken up with a platinum wire or by moistening the cold carbonaceous residue with water, drying and then gently re-igniting. Caring was taken while moving the dishes which contain fluffy ashes. The dishes were covered with a petri dish after placing in the desiccators prior to weighing.

Procedure: percentage of total ash.
Weight of empty dish =X g.
Weight t of dish +sample=Y g.
Weight t of dish + ash= Z g

$\frac{Z- X}{Y-X} * 100$ (18)

**Determination of Protein, Fat, Lactose and SNF "Principles of Measurements in Lactostar"**

Lactostar adopts combined thermo-optical procedures for the analysed samples. The Lactostar measures both thermal and optical qualities of the samples.

**Optical Measurement Procedures:**

All non-solved contained substances contribute to the turbidity. By measuring turbidity the sum of fat content and protein can be measured.

**Thermo Analysis:**

Fat content and SNF content results from thermo-physical effects and their arithmetical.

**Computational Analysis:**

Protein content can be assessed by forming differences between the result of optical measurement and the fat content [20].

**Determination of Acidity**

The acidity of milk is usually determined by direct titration. The experiment starts with dissolving of 1 g of phenolphthalein in 110 ml of ethyl alcohol (95 percent v\v) and added 0.1M sodium hydroxide solution until one drop gives a faint coloration and made up to 200 ml with distilled water. After that a 0.12g of rosaniline was dissolved acetate in 50 ml ethyl alcohol (95percent v\v) containing 0.5ml of glacial acetic acid, then madding up to 100 ml with ethyl alcohol (95percent v\v) and store in a dark. 'Solution A'. After that a 1ml of solution A to 500ml was diluted with a mixture of ethyl alcohol (95percent v\v ) and distilled water in equal proportions by volume. A pipette 10ml of milk into each of two basin C and S. And to the colour control basin C besides a 1ml of rosaniline solution B was added and stir. Then to sample basin S a 1ml of the phenolphthalein indicator was added and titrate with 0.1 M sodium hydroxide, stirring continuously, until the colour matches the pink colour of C. Finally, the acidity was calculated as lactic acid (per cent m\v) [18].

**Determination of freezing point**

Proper measurement of the freezing point can be effected by means of a cryoscope. However, as lactostar can determine the contents of protein and non-fat dry substance in milk. The freezing point to be expected on the basis of these values can be predicted by deducting the protein content from non-fat dry substance, and then lactose, urea and salt will remain whose content determines directly the freezing point [18].

**Statistical analysis**

All data was organised and coded prior to being entered in a computer. Description and analysis of data was done by SPSS version 16. Level of significance was set at p value < 0.05. Descriptive

statistics includes frequency (number and percent); arithmetic mean and standard deviation were calculated. for protein, fat, solid non-fat and carbohydrates in table 2. Figures from 1-5 illustrate the comparison between the labelled values and the values which the researchers find during analysing the samples during the study.

## RESULTS

The proximate analysis composition of evaporated milk for energy, moisture and ash in table 1. The proximate analysis composition of evaporated milk

**Table 1: The proximate analysis composition of evaporated milk for energy, moisture and ash**

| Milk Brands | Energy(kcal)/ 100 ml | | Moisture % | Ash % |
|---|---|---|---|---|
| | Study | Label | Study | Study |
| M1 | 135 | 146 | 74.05 | 1.71 |
| M2 | 125 | 139 | 74.59 | 1.63 |
| M3 | 129 | 137 | 74.14 | 1.49 |
| M4 | 139.8 | 139 | 75.00 | 1.44 |
| M5 | 121.9 | - | 74.61 | 1.42 |
| M6 | 130.3 | - | 73.86 | 1.56 |
| M7 | 124 | 139 | 77.10 | 1.48 |
| M8 | 131.5 | - | 74.16 | 1.53 |
| M9 | 131.5 | 132 | 75.08 | 1.49 |
| M10 | 125 | 139 | 74.74 | 1.63 |
| M11 | 142.6 | - | 74.23 | 1.57 |
| M12 | 143.4 | - | 73.97 | 1.44 |
| M13 | 126.6 | - | 76.33 | 1.34 |
| M14 | 124 | 139 | 76.44 | 1.51 |
| M15 | 125 | 139 | 76.62 | 1.52 |
| M16 | 121 | 134 | 76.06 | 1.41 |
| M17 | 139.6 | 139 | 76.37 | 1.41 |
| Mean± SD | 130.306±7.33 | 138.36±3.5 | 75.138±0.064 | 1.505±0.0947 |

**Table 2: Composition of evaporated milk for protein, fat, solid non-fat and carbohydrates**

| Milk Brands | Fat % | | Protein % | | Carbohydrates % | | Solid Non Fat % | |
|---|---|---|---|---|---|---|---|---|
| | Study | Label | Study | Label | Study | Label | **Study** | **Label** |
| M1 | 7.36 | 8.5 | 6.02 | 7 | 10.05 | 10.2 | 18.09 | 7 |
| M2 | 6.47 | 8 | 6.07 | 6.9 | 10.15 | 9.8 | 18.25 | 17.5 |
| M3 | 7.31 | 8.1 | 5.91 | 6.5 | 9.87 | 10.6 | 17.76 | - |
| M4 | 7.98 | 8 | 6.94 | 6.9 | 10.06 | 9.8 | 18.11 | - |
| M5 | 6.66 | 7.5 | 5.79 | - | 9.70 | - | 17.43 | - |
| M6 | 7.45 | 8 | 5.93 | 6.5 | 9.89 | - | 17.80 | - |
| M7 | 6.83 | 8 | 5.84 | 6.9 | 9.76 | 9.8 | 17.55 | 17.5 |
| M8 | 7.51 | 8 | 6.00 | - | 10.00 | - | 18.01 | 17.5 |
| M9 | 7.51 | 7.50 | 6.00 | 6 | 10.00 | 10.2 | 18.01 | - |
| M10 | 6.85 | 8 | 5.91 | 6.9 | 9.89 | 9.8 | 17.78 | - |
| M11 | 8.31 | 8 | 6.93 | - | 10.03 | - | 18.08 | 17.5 |
| M12 | 7.51 | 8 | 6.00 | - | 10.00 | - | 18.01 | 17.5 |
| M13 | 7.16 | 8 | 5.82 | - | 9.72 | - | 17.48 | 17.5 |
| M14 | 6.80 | 8 | 5.85 | 6.9 | 9.78 | 9.8 | 17.59 | 17.5 |
| M15 | 6.84 | 8 | 5.87 | 7.3 | 9.81 | 9.4 | 17.64 | 17.5 |
| M16 | 6.62 | 8 | 5.73 | 6.4 | 9.60 | 9.7 | 17.25 | - |
| M17 | 7.03 | 8 | 6.9 | 6.9 | 10.00 | 9.8 | 18.01 | - |
| Mean | 7.188 | 7.976 | 6.089 | 6.758 | 9.901 | 9.9 | 17.815 | 16.3333 |
| SD | 0.498 | 0.217 | 0.408 | 0.345 | 0.153 | 0.319 | 0.286 | 3.5 |

**Table 3: Composition of evaporated milk for acidity, PH and freezing point in**

| Milk Brands | Acidity | PH | Freezing Point $C^0$ |
|---|---|---|---|
| | Study | | |
| M1 | 0.540 | 6.2 | 0.526- |
| M2 | 0.495 | 6.1 | 0.529- |
| M3 | 0.540 | 6 | 0.498- |
| M4 | 0.540 | 6.1 | -0.528 |
| M5 | 0.540 | 6.2 | 0.464- |
| M6 | 0.567 | 6.1 | 0.503- |
| M7 | 0.540 | 6.3 | 0.475- |
| M8 | 0.540 | 6.2 | -0.520 |
| M9 | 0.450 | 6.5 | 0.521- |
| M10 | 0.540 | 6.3 | 0.495- |
| M11 | 0.558 | 6.3 | -0.529 |
| M12 | 0.549 | 6.1 | 0.520- |
| M13 | 0.540 | 6.5 | 0.473- |
| M14 | 0.540 | 6.4 | 0.479- |
| M15 | 0.666 | 6.4 | -0.483 |
| M16 | 0.495 | 6.7 | 0.449- |
| M17 | 0.738 | 6.4 | -0.521 |
| Mean | 0.552 | 6.282 | 0.552 |
| SD | 0.0643 | 0.185 | 0.064 |

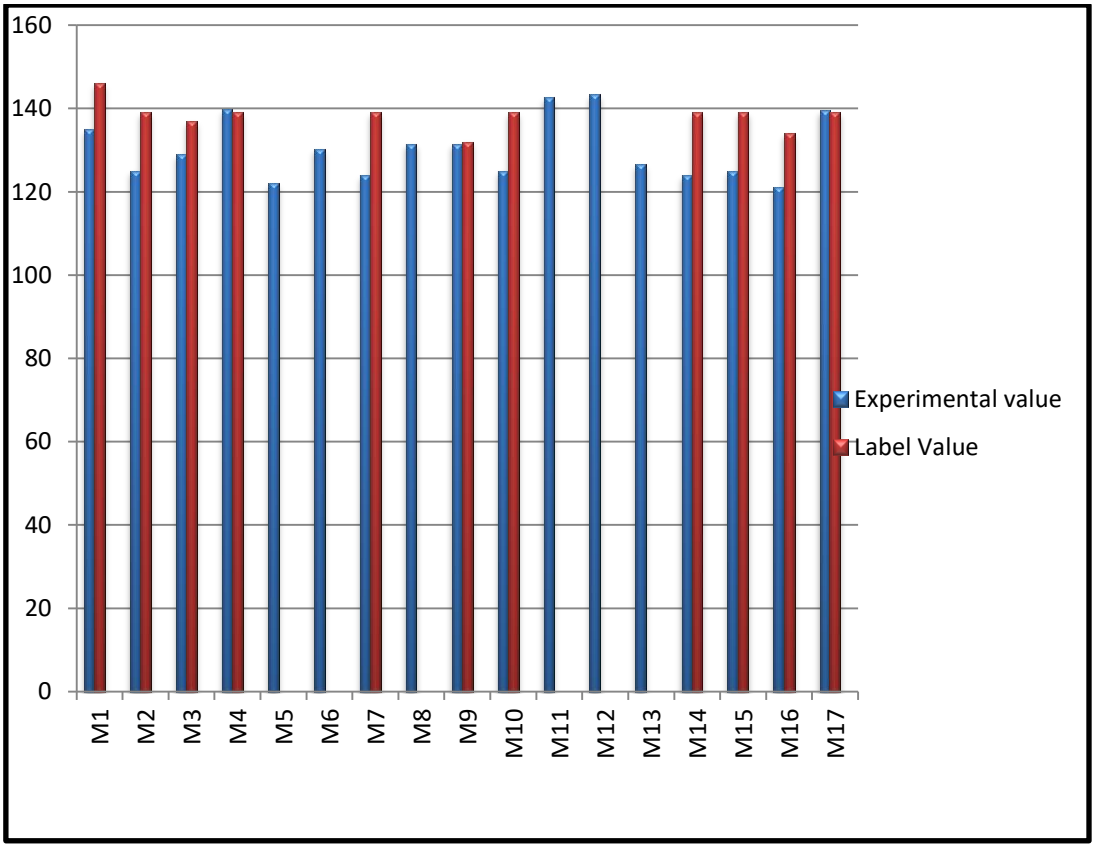


**Fig 1: Analytical data for energy in evaporated milk**

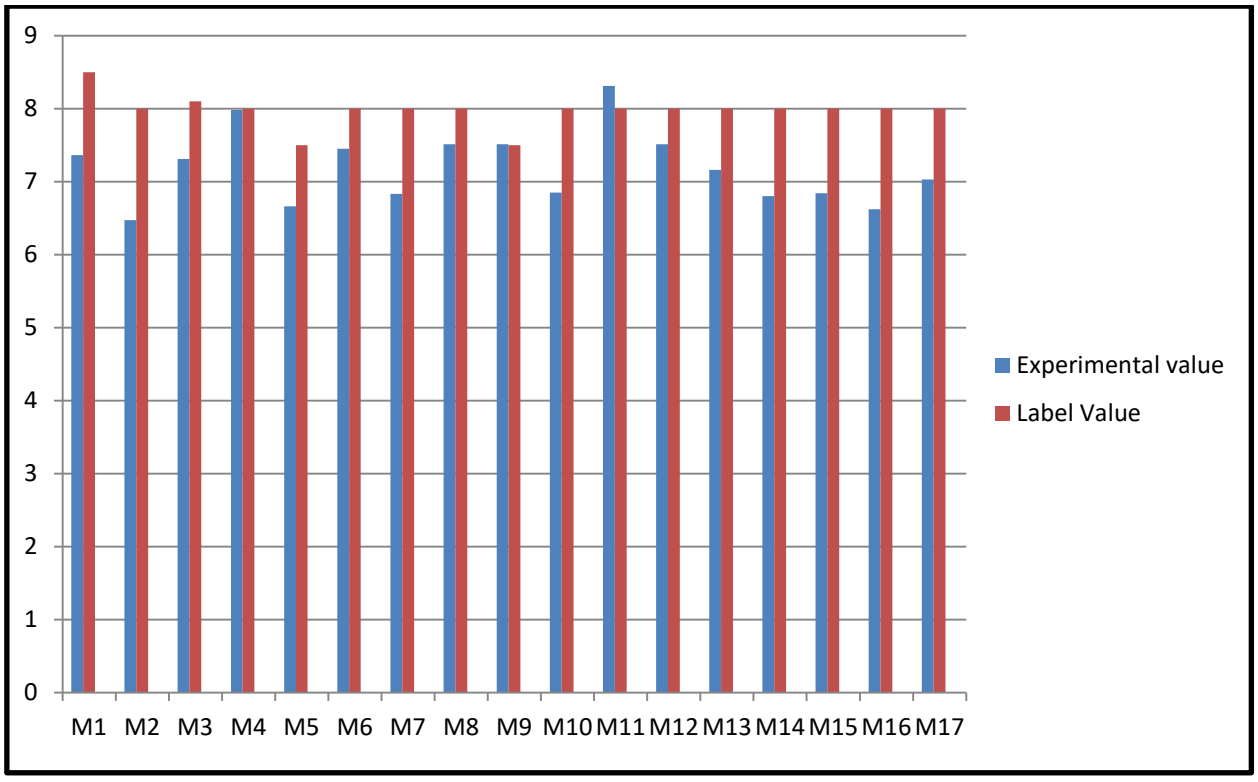


**Fig 2: Analytical data for fat in evaporated milk**

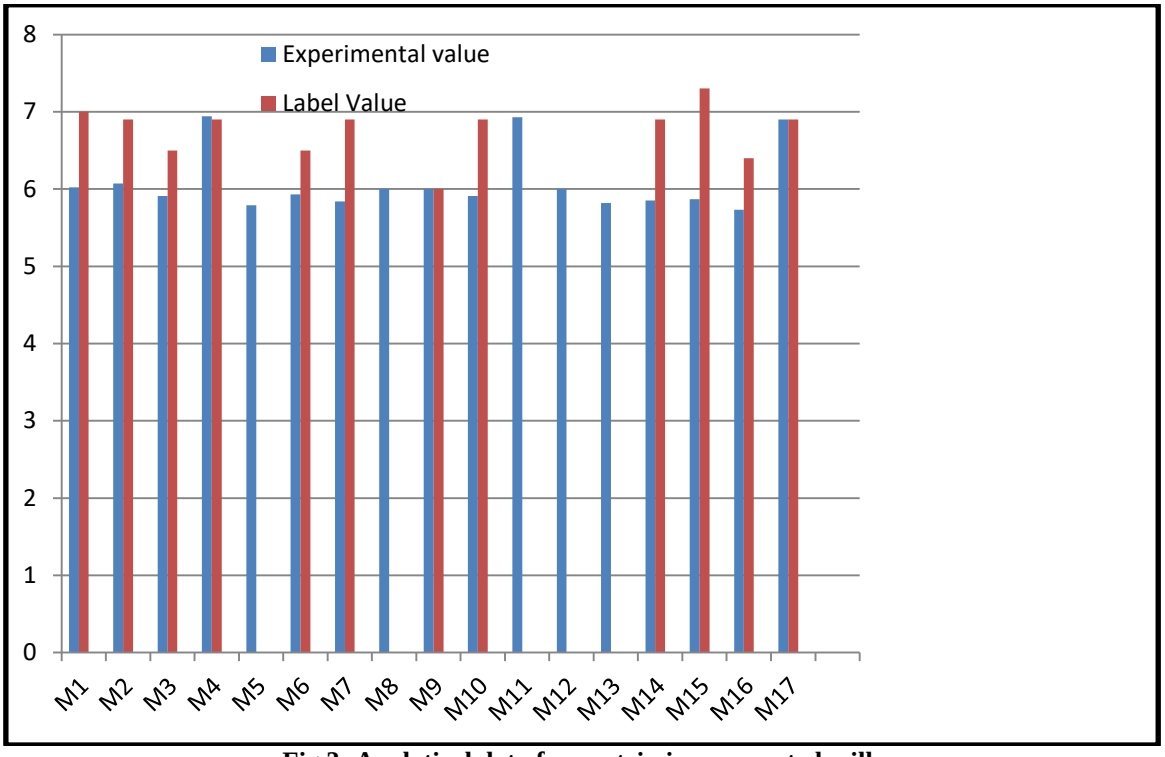


**Fig 3: Analytical data for protein in evaporated milk**

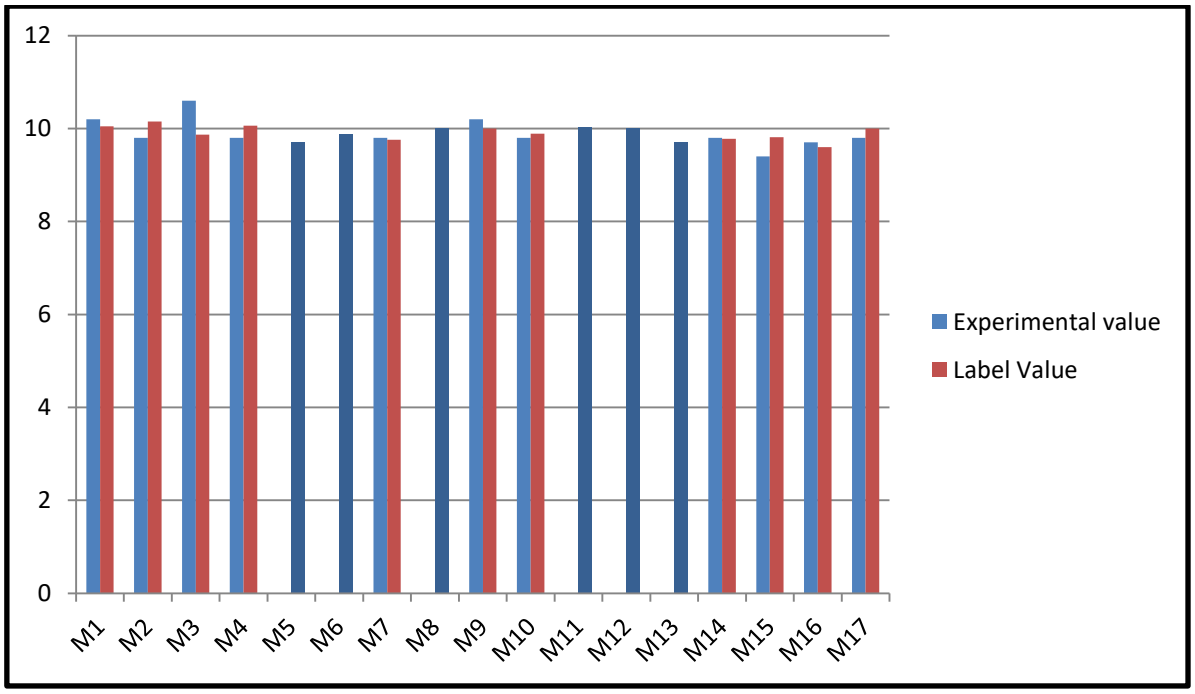


**Fig 4: Analytical data for lactose in evaporated milk**

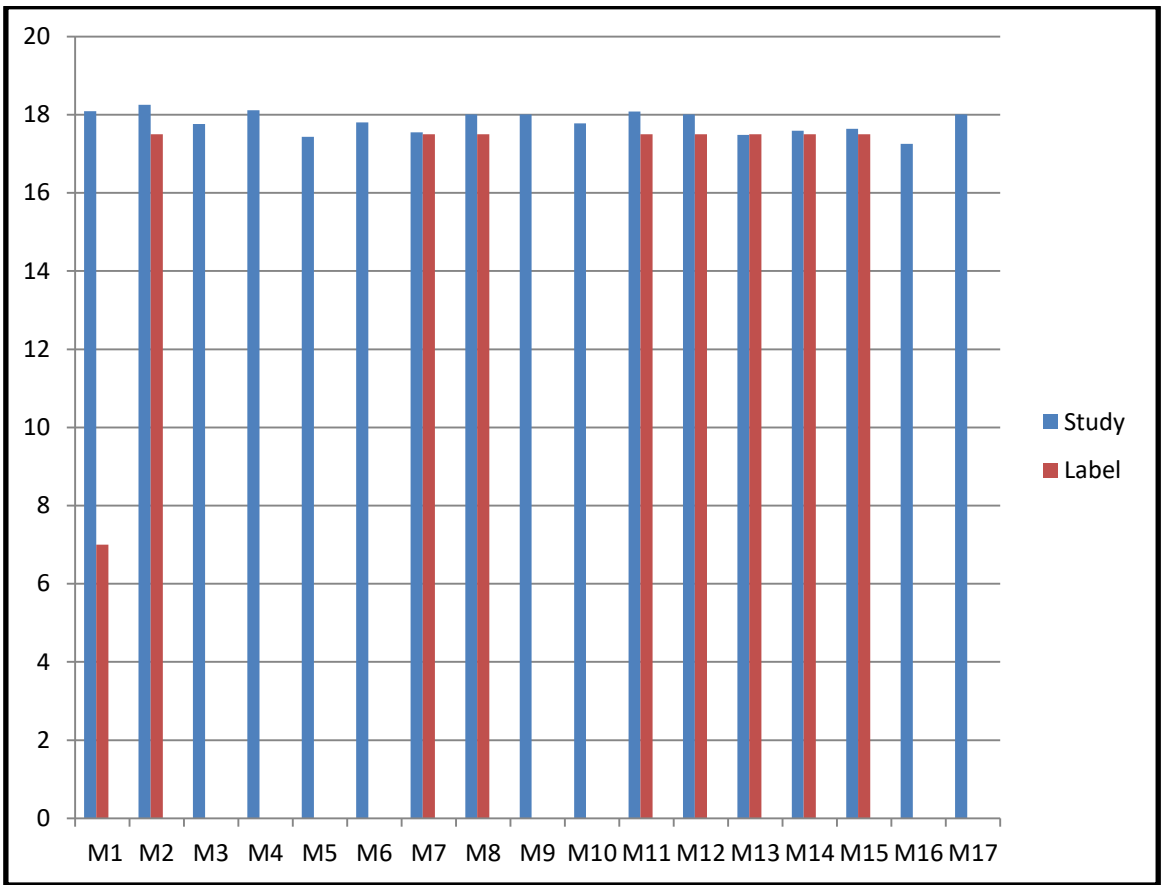


**Fig 5: Analytical data for total non-solid fat in evaporated milk**

## DISCUSSION

Evaporated milk is a condensed milk which is produced by removal of 60% of water from the normal cow milk. As a result of this process all the ingredients of evaporated milk increase in the concentration which become almost exactly of twice of that of normal milk. In this study, seventeen commercial brands of evaporated milk were collected from the local markets and were analysed to determine the proximate composition, PH, freezing point, ash, moisture, protein, fat, energy, lactose, SNF and acidity. The result has presented in tables from (table 1 to 4) and figures from (1 to 5) [18, 20]. The analysed mean values of total energy have been found to be (130±7.33) which is closed to result by Fovarosi [20]. For acidity, the mean has been (0.552± 0.064) which is closed to result stated by Eriksen and langdah [21]. Ash and protein (1.505 ±0.0947), (6.758±0.345) which is closed to result stated by Sikand *et al.;* [22]. While fat and solid non-fat (7.188 ±0.498), (17.815±0.286) which are closed to result stated by Huppertz *et al.;* [23]. Ash, fat, protein, lactose and solid non-fat, have been found to be the most varied values among different studies [24-27]. The moisture and ash has not been given by the producers. However, the other results are in very close agreement when compared with the labeled values given by the producers. Moreover, the results are in full compliance with those given in Libyan standard (appendix I) and codex standard (appendix II) for the evaporated milk. The total ash, moisture, protein, fat and SNF in Libyan standard and codex standard has been found to be (1.50), (75), (25), (6.50), (7.50), (17.50), respectively. PH value is related to acid- base condition of food staff which is scientifically defined as the negative logarithm of hydrogen ion concentration. PH of fresh milk always remains on the neutral side which ranges from 6.5 to 7. The mean of analysed values is (6.3 ±0.185) which is closed to neutral side showing the quality of milk is good [26].

In term of acidity, the mean has been (0.552±0.0643); which is closed to international and Libyan standers. Finally, FPP the mean has been (0.552±0.064); which also to international and Libyan standers [25, 27]. Studies have examined nutritive differences in the composition of evaporated milk. These studies generally suffer from confounding variables, and are difficult to generalize due to differences in the tests that were done, the season of testing and brand of milk tested, and because the vagaries of agriculture affect the nutritive composition of evaporated milk. Treatment of the foodstuffs after initial gathering (whether milk is pasteurized or raw), the length of time between milking and analysis, as well as conditions of transport and storage, also affect the chemical composition of a given batch [18]. For the imported evaporated milk, the mean values of fat content ranged from 6% to 8.5 % for different brands [19]. While the total solids content ranged from 15% to 18% [18, 20]. In another study done by Chen (1994) fat content of all the evaporated milk samples with means ranging from 9·09 % 9.16 % for Peak [21].

Evaporated Milk conformed to the label declaration of 9% fat content [19]. In another study done by Bargo (2003) the total solids content of the evaporated milk samples had means ranging from 31·23 % to 31.96 % for Nestle Ideal Milk [22]. The results indicate that the evaporated milk samples analysed were well above the FAO standard of minima of 7·5% fat by weight and 25·0% of milk solids by weight (FAO/WHO, 1968) [19]. A 2012 meta-analysis of the scientific literature did not find significant differences in the nutrients content of different types of evaporated milk, and found that results varied from study to study. The authors found 4 studies on each of beta-carotene and alpha-tocopherol levels in milk; differences were heterogeneous and not significant. The authors found few studies on fatty acids in milk; all (but for one) were of raw milk, and suggest that raw organic milk may contain significantly more beneficial omega-3 fatty acids than raw conventional milk. The authors found no significant differences between different types of evaporated milk and conventional milk with respect to total protein, total fat, or 7 other vitamins and fatty acids tested [18-21]. A less comprehensive review looking only at data from studies published before 2005 found that different types of evaporated milk contain significantly higher protein, total omega-3 fatty acid, and 5 other fatty acids, but less linoleic acid, oleic acid, and omega-6 fatty acids than those of conventional produced milk. It also found that organic different types of evaporated milk have significantly higher omega-3 to -6 ratio and Δ9-desaturase index than the conventional types[19].

## CONCLUSION

Seventeen brands of evaporated milk marked in Benghazi were analysed to evaluate the proximate values of total energy, moisture, ash, fat, protein, lactose, solid nonfat, acidity, FPP and PH. The analysed results were compared to labeled values by the producers which found to be in close agreement. The analysed values were also being found in compliance with Libyan standers and codex standers. The project has aimed to compare the nutritive values of different types of evaporated milk which available in local marketing in Benghazi city.

The milk brands were coded from M1 to M17. These samples were analysed in laboratories of Nutrition Department – Faculty of Public Health Benghazi University. The proximate composition (fat, protein, lactose, FPP and solid non-fat) were analysed by Lactostar. Lactostar usually provides accurate, valid and rapid results. It is recommended that further studies are required to investigate the essential and trace elements, vitamins and effects of heating during evaporated milk manufacturing. It is recommended that further studies are required to investigate the effects of storage and transport on evaporated milk quality. Since the evaporated milk provides a wide range of nutrients, it is recommended to assess the consumption pattern and consequences of this pattern among different age groups in Libyan communit.

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