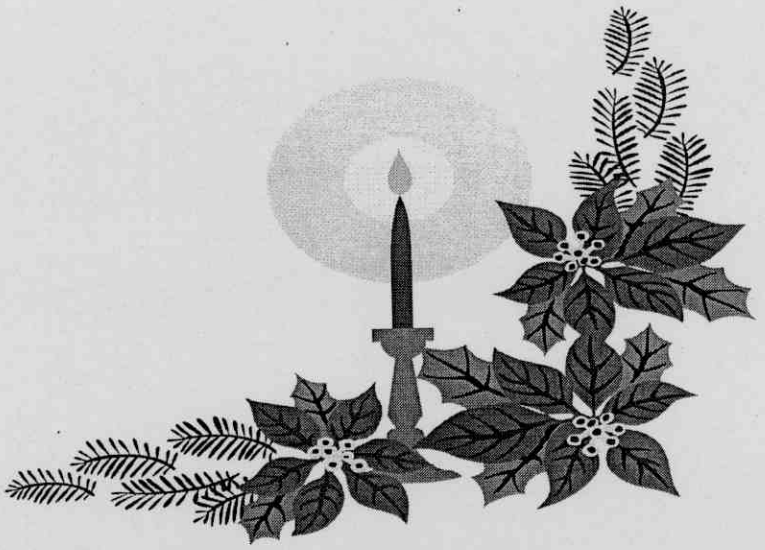
SUMMARY & CONCLUSION



V. ENGLISH SUMMARY

The present investigation is presented in two main parts, which will be covered under the following titles:

Part I: Tamarind:

Two tamarind starting materials examined included compressed packaged samples; an Egyptian Aswan variety and an Indian Makham waan variety. The two compressed packaged samples (Aswany and Indian) were separated carefully into their constituent pulp and the enclosed seeds.

1- Physicochemical analysis of tamarind materials used in the experimental preparation of beverages:

- Moisture content ranged between 18.93 to 20.77%. Indian variety showed the highest content of moisture, while the Aswany variety had the lowest content.
- Total carbohydrates constituted the major component in tamarind varieties tested where ranged between 74.13% to 78.72% on dry weight basis. Aswany variety exhibited the highest total carbohydrates while compressed packaged Indian variety showed the lowest content.
- Tamarind pulp was found relatively poor in crude fat (averaged from 0.86% to 0.91% on the dry basis) but not in crude protein content (averaged from 4.63% to 4.80% on dry basis). The compressed packaged Aswany variety had the highest protein content (4.80 %), while the Indian variety showed the lowest content (4.63%).
- Tamarind pulp was proved to contain a good quantity of ash content, which ranged between 4.02% to 6.79% on the dry basis. The highest content was for the packaged Indian variety.
-Crude fiber content ranged between 11.63% to 13.56% on dry weight basis. The Indian variety exhibited the highest content of crude fibers.

-Total soluble sugars contents of pulp ranged from 58.20% to 60.18% on dry basis. Reducing sugars ranged from 43.74% to 45.85% on dry weight basis. Aswany variety exhibited the lowest total and reducing sugars contents while the Indian variety showed the highest content.

-The acidity values for tamarind varieties ranged between 9.68% to 10.18%. pH values were 2.81 and 2.87 for compressed packaged Indian variety and compressed packaged Aswany variety.

-Tamarind pulp can be considered as a good source for ascorbic acid, which ranged between (4.25-5.46 mg/100g). The packaged Indian variety had the highest content of ascorbic acid. Tannins content of the tested pulps ranged between 0.03 to 0.05%.

-The color index values (O.D. at 420 nm) recorded for tamarind pulp extracts were 6.64 and 7.864 for Aswany and Indian varieties. Anthocynin content of tamarind pulp extracts ranged between 2.04 to 2.05 mg/100 g. The highest value present in the Indian variety.

2. Microbiological quality of tamarind pulp:

- Total bacterial count of the different varieties for Aswany and Indian varieties were: $1.06x10^4$ and $6.35x10^2$ c.f.u./g, respectively. Moreover, yeasts and molds counts were $6.9x10^2$ and $4.9x10^2$ c.f.u./g, respectively. The highest total microbial count, yeasts and molds were found in the compressed packaged Aswany variety while, the lowest values were found in Indian variety.

- *Lactic acid bacteria* counts in the different Aswany and Indian tamarind were $2.4x10^2$ and $1.2x10^2$ c.f.u./g, respectively. Moreover, *Psychrophylic bacteria* counts were $1.94x10^2$ and $1.6x10^2$ c.f.u./g, respectively. The highest *Lactic acid bacteria* and *Psychrophylic* bacteria counts were found in Aswany variety while, the lowest were found in the Indian variety. Both varieties were found free from *Sporformer bacteria*, *Colifrom bacteria* and *Staphylococcus*.

3. Chemical analysis of tamarind seeds:

- The lower content of moisture (8.85%) was found in the compressed packaged Aswany variety, while the higher content in compressed packaged Indian type (8.91%).
- Total carbohydrates ranged between 69.58% to 70.19% on dry basis. Aswany variety showed the higher content while the Indian variety exhibited the lower.
- Crude fibers in seeds ranged between 5.68% to 6.97% on dry basis. The higher content was recorded for the Indian variety, while the lower was in the Aswany.

-Total soluble and reducing sugars content of seeds ranged, on the dry basis, between 11.93% to 13.78% and between 7.26% to 8.66%, respectively. The higher total and reducing sugars content was recorded for seeds of Aswany variety, while the lower contents were in seeds of the Indian variety.

4. Establishment of optimum extraction conditions for tamarind pulp:

The various factors, which influence maximum extractability of tamarind pulp components into acceptable beverages, were investigated. With all extraction experiments; extraction were performed in triplicate successive trials (re-extraction trials) at the same conditions employed under study.

- **Effect of flotation ratio (water: pulp) on extraction rate of tamarind pulp from different varieties:**

-There was a general trend of gradual decrease for (T.S.S.) and (O.D.) with the increase in flotation ratio from 2: 1 to 10: 1. In contrast, pH of extraction medium, which was strongly acidic, increased gradually with the increase in flotation ratio. The highest T.S.S. and O.D values for the Indian variety (23.83% and 4.442, respectively) and for the Aswany (23.00% and 3.682, respectively) were attained with flotation ratio of 2:1. However, the lowest values were attained at flotation ratio of 10:1 where lowest proportions of extract total soluble solids were 7.57% and 6.16% for two varieties, respectively.

- **Effect of temperature degree on extraction rate of tamarind pulp from different varieties:**

-As a general rule, as temperature of extraction increased as total soluble solids content and optical density increased. In contrast, pH value decreased with the increase in degree of temperature.

-Experiments using Indian and Aswany tamarind varieties indicated that maximum T.S.S. achieved after first extraction trial at 100 °C was 26.50% and 26.17%, respectively. The 2nd re-extraction added another 12.50 and 12.50% respectively. After the three successive re-extraction trials, the maximum cumulative extraction reached 43.83% and 43.83%, respectively, in tamarind pulps.

- **Effect of extraction periods on extraction rate of tamarind pulp from different varieties:**

-In a general rule, as the duration of extraction increased as the T.S.S. content and O.D. increased. However, such increase was not pronounced with increasing period of extraction longer than 30 min. In contrast, pH value decreased with the increase in duration of extraction.

-The maximum T.S.S. and O.D. values achieved after extraction period for 120 min. in hot water. After the first extraction trial, T.S.S. in the Indian and Aswany tamarind varieties reached 27.50 and 27.00%, respectively, which represent a net recovered T.S.S. (from the total contained in the three starting pulp powders) of about 34.71 and 33.30%, respectively. The 2nd re-extraction added another 14.67 and 13.50%, respectively, which represents 18.52 and 16.65%, respectively of the total solids contained in tamarind pulps. After the three successive re-extraction trials, the maximum cumulative extraction reached 46.67 and 46.00 %, respectively, which represents 58.91 and 56.74%, respectively of the total solids contained in pulp of tamarind varieties.

-An optimum extraction period only 30 min at hot temperature condition of was selected as a compromise between speed of extraction and maximum extractability of components of tamarind varieties.

- **Effect of pH medium on extraction rate of tamarind pulp from different varieties:**

-Generally, as pH of extraction medium increased as total soluble solids content and optical density increased until pH 7 then decreased. However, such increase was not pronounced with increasing pH of extraction medium more than 7.

-With hot, semi-hot and room temperature conditions, the maximum T.S.S. was achieved when pH value of extraction medium was pH= 7. It was concluded that an optimum pH medium of extraction at the different temperature conditions was pH=7.

- **Effect of different extraction conditions on sensory evaluation for tamarind extracts:**

- The ANOVA indicated that there were significant differences ($P \geq 0.05$) between the different treatments for the variable flotation ratios and conditions of extraction in all scores given for taste, odor, texture and overall acceptability scores. The highest scores were given to treatment of flotation ratio (2: 1) executed at hot condition, while the lowest were given to that treatment of flotation ratio (10 : 1) at room temperature.
- High significant differences ($P \geq 0.05$) existed between the treatments of different extraction periods and methods of extraction in all given scores. The highest scores were attained by treatment at hot condition for 30 min - High significant differences ($P \geq 0.05$) existed between treatments prepared under different degrees of hot temperatures in all given scores. The highest scores were attained by that treatment prepared at 100°C.

5. Survey study of tamarind beverage samples collected from some Egyptian local markets:

-The survey study employed 15 different samples collected from different local markets from different places of Egypt. Ten of these samples were recognized as natural-made beverage, while the other five samples were known to be synthetic or commercial beverages.

- **Survey study on natural tamarind beverages:**

- Physicochemical tests revealed that natural beverage samples were characterized with a high content of total sugars, which ranged from 11.90 to 23.34%. Reducing sugars content ranged from 0.61 to 2.30%. Total soluble solids content ranged between 12.17 and 23.50%. All survey samples, on as is basis, exhibited low protein values (from 0.06 to 0.33%) while ash content ranged between 0.06 and 0.15%. Values for titratable acidity, pH value, anthocyanin content, specific gravity and refractive index in survey tamarind beverages samples ranged from 0.05 to 0.25% ; from (2.54 to 3.89), (0.311 to 0.908), (1.0476 to 1.0978) and (1.3529 to 1.3700) ,respectively.

-Examination of the microbiological quality of natural tamarind beverages indicated that the total microbial count present in the collected samples ranged between $9x10^3$ c.f.u./ml and 8.1x105 c.f.u./ml. Yeast and mold counts ranged from $4.1x10^3$ c.f.u./ml to $5.9x10^5$ c.f.u./ml. *Sporformer bacteria* and *Staphylococcus* were not detected in all the collected samples. *Lactic acid bacteria* count ranged from $7.2x10^2$ to $1.6x10^5$ c.f.u./ml. *Psychrophylic bacteria* count ranged from $1.54x10^3$ c.f.u./ml and $1.36x10^5$ c.f.u./ml. *Coliform bacteria* was present in most samples(ranged from $3.6x10^2$ c.f.u./ml to $7.8x10^3$ c.f.u./ml), except samples No. 5 and No. 7.

- **Synthetic tamarind beverages:**

-Physicochemical tests revealed that T.S.S ranged from 11.50% to 14.50%. Total sugars are considered the main component (11.38 to 14.27%) while reducing sugars ranged from 0.52 to

1.89%. All synthetic beverages did not contain any crude protein or fat contents, but had low ash content, which ranged from 0.01 to 0.02%. Titratable acidity ranged from 0.17 to 0.29%, while pH value ranged from 3.12 to 3.66. Values for specific gravity and refractive index in synthetic beverage samples ranged from (1.05 to 1.06) and from 1.35 to 1.36, respectively.

-Microbiological tests for synthetic tamarind beverages illustrated that total microbial load in the survey samples ranged between $4.85x10^4$ c.f.u./ml and $1.1x10^6$ c.f.u./ml. Synthetic beverages were highly contaminated with yeasts and molds which ranged from $2.7x10^3$ to $7.4x10^5$ c.f.u./ml. *Sporformer bacteria* and *Staphylococcus bacteria* were not detected. Synthetic beverages were less contaminated with *Lactic acid bacteria*, *Psychrophylic bacteria* and *Coliform bacteria* compared to the natural beverages. The *Lactic acid bacteria* ranged from $4.5x\ 10^2$ to $8.3\ x10^4$ c.f.u./ml

- **Comparison between characteristics of collected survey natural and synthetic tamarind beverage samples:**

- It was observed that there are many factors, which could be taken as parameters to differentiate between the natural and synthetic tamarind beverages. The natural tamarind beverages were distinguished with higher contents in total carbohydrates, total soluble sugars, reducing sugars, total ash content, crude protein ascorbic acid and anthocynin pigments. Synthetic tamarind samples were found to be characterized by intense color, with sharp and tangent flavor and were found to be free from anthocynin pigments and from protein.

6. Essential minerals of tamarind pulp:

-Both of tamarind samples investigated were found to contain appreciable content of mineral matter. However, compressed packaged Indian variety contained the highest mineral matter content compared to compressed packaged Aswany. However, tamarind varieties contained appreciable amounts of calcium, sodium and phosphorus, which were the 1st, 2nd and 3rd major

mineral element, respectively, as they ranged from 157.34 to 438.21 mg/100g, 76.41 to 114.33mg/100g and 54.60 to 106.10mg/100g, respectively.

-The essential micro minerals in tow tamarind pulp varieties were ranked, in a decreasing order of abundance as follows: copper, iron, and zinc, which were the 1st, 2nd and 3rd micro mineral element, respectively, as they ranged from 16.18 to 20.64 mg/100g, 1.70 to 3.50 mg/100g and 0.30 to 0.70 mg/100g, respectively. Manganese element was not detected in both tamarind varieties.

- The content of only 200g of tamarind pulp could satisfy or cover most of the daily requirements (DR) for adult humans from calcium and the DR for children from iron -1/2 the DR for adults from magnesium and 1/2 that for children's at low bioavailability from zinc and 1/2 the DR for adults from iron at 15% bioavailability ;1/5th the DR for adult humans from zinc at high bioavailability ; 1/6the DR from phosphorus and 1/10 the DR from potassium as indicated by **WHO and FAO (2004).**

7. Study of volatiles components of tamarind pulp:

-Combined technique of gas chromatography/ mass spectroscopy (GC-MS) revealed that 22 volatile components were fractionated from the aroma concentrate of the Egyptian tamarind variety Aswany of which only sixteen were identified. The identified volatiles ranked in order of decreasing abundance were as follows: 2-furancarboxaldehyde (58.11%), di-(2- ethyl hexyl phthalate (16.53%), 5-methyl furfural (4.61%), phenol (4.29%), Limonene (3.28%), 1,2- benzenedicarboxylic acid (1.58%) ,phenyl acetaldehyde (1.55%), 2,6 di(t-butyl 0.65%), 1-Nonadecane (0.53%), Tetradecane (0.45%), Octadecane (0.45%), Pentadecane (0.43%), Hexadecane (0.33%), 1-Hexadecane (0.23%), Heptadecane (0.21%) and 1-Octadecane (0.18%).

-The fractionated and identified volatile constituents from aroma concentrate of the Indian tamarind variety were 36 and 26 compounds, respectively. The major constituents ranked, in order of decreasing abundance, were as follows: 1, 2-

benzendicarboxylic acid (19.39% of the total volatiles), hexanoic acid (15.56%), 2- furancarboxaldehyde (13.23%), 1- propanone (5.17%), Limonene (4.23%), 4- hydroxyl-5-methoxyprimidine (3.98%), octanoic acid (3.37%), Dibutyl phthalate (2.24%), Phenol (1.61%), 9-Octadecenamide (1.43%), Hexadecanamide (1.28%), 9-Octadecenoic acid (1.08%), Propanal (0.88%)5-Acetoxymethyl-2-furaldehyde (0.78%), Benzeneacetaldehyde (0.75%), Hexadecanoic acid (0.57%), 1-Octadecane (0.52%), Butyl citrate (0.42%), Heptadecane (0.41%), 1-Hexadecane (0.39%), Tetradecane (0.35%), Hexadecane (0.34%), Methyl-3-(3,5-ditertbutyl-4-hydroxyphenyl (0.32%), Octadecane (0.25%), 9-Methylnonadecane (0.25%) and Ethyl acetate (0.07).

-The differences existed between the Egyptian and Indian tamarind varieties in aroma profile were not only exist with the number of constituent volatiles identified, but also with in the identity of the volatile identified .The first major constituent in the Aswany variety was 2-furancarboxaldehyde which constituted 62.11% of the total volatiles identified, while in the Indian tamarind variety, the first major constituent was 1,2-benzendicarboxylic acid which constituted 26.08% of total volatiles identified,

Part II: Carob:

Two carob starting materials were employed which included whole and crushed samples of Cyprian carob (Tylliria variety). Whole carob pods were separated carefully into their constituent pulp and enclosed seeds.

1. Physicochemical analysis of carob materials used in the experimental preparation of beverages:

- **Chemical composition:**

- No significant difference in contents in total solids and moisture were observed between whole carob pods (92.04%and 7.96%) and crushed carob (92.03 and 7.97%). Total carbohydrates, the main component in carob, ranged from

85.32% to 86.08% on dry basis. Higher content of carbohydrates was found in crushed carob. Crude fibers content ranged between 6.14% to 7.50% on dry basis. A higher content for whole carob pods was noted.

-Total soluble sugars and reducing sugars ranged (on dry basis) between 51.40% to 54.22% and between 14.56% to 15.76%, respectively. Higher content of total and reducing sugars was found in crushed carob.

-Total acidity and pH values were 0.53% and 4.84, respectively, for crushed carob while these values were 0.66% and 4.80, respectively, for whole carob pods. Color index values (O.D. at 420 nm.) recorded for whole pods and crushed sample were 1.225 an 1.383, respectively. The anthocynin contents were 0.531 and 0.597 mg/100g, respectively.

2. Microbiological quality of carob pulp:

-A higher total bacterial count ($4.37x10^4$ c.f.u./g) was observed in crushed carob pods, but lower count ($9.45x10^3$ c.f.u./g) was in whole carob pods. Furthermore, higher counts ($8.21x10^3$ c.f.u./g) of yeasts and molds were in crushed pods, but lower counts($3.4x10^3$ c.f.u./g) were in whole pods. Lower *Coliform group* count ($1.1x10^3$ c.f.u./g) was noted in whole pods, but higher count ($9.4x10^3$ c.f.u./g) was in crushed pods. *Sporeformer bacteria, Lactic acid bacteria, Psychrophylic bacteria* and *Staphlococcus* were not detected in both carob samples.

3. Chemical analysis of carob seeds:

-Total carbohydrates were found to be the main constituent in carob seeds where reached 70.07% on dry basis. Total solids content was 91.11% and moisture was 8.89%. Carob seeds could be considered a good source for crude protein and fat compared to carob pulp where, on dry basis, crude protein content reached 12.75%, but crude fat was 6.28%. On dry basis, ash content reached 2.81% while crude fibers content was 8.09%. Total soluble, reducing and non-reducing sugars content were 12.35%, 7.84% and 4.51%, respectively, on dry basis.

4. Establishment of optimum extraction conditions of carob pulp:

The various factors which influence maximum extractability of carob pulp components into acceptable beverages were investigated. With all extraction experiments; extraction were performed in triplicate successive trials (re-extraction trials) at the same conditions employed under study.

*Extractability of the Cyprian whole and crushed carob variety:

- **Effect of flotation ratio (water: pulp) on extraction rate of whole and crushed carob pulp:**

-A general trend of gradual decrease in T.S.S. and O.D. was observed with the increase in flotation ratio from 2: 1 to 10: 1. In contrast, pH value of extraction medium, increased gradually with the increase in flotation ratio. The highest values for total soluble solids and optical density (20.83% and 1.631, respectively) for whole carob and for crushed carob (19.00% and 1.447, respectively) were attained with flotation ratio of 1:2 (carob water: pulp). On the other, the lowest values for T.S.S and O.D. (5.17% and 0.612, respectively) for whole and for crushed were (4.17% and 0.587, respectively) were attained at flotation ratio of 10:1 (carob water: pulp). In addition, the lowest proportions of extracted total soluble solids were (5.61%) and (4.53%), respectively.

- **Effect of temperature degree on extraction rate of pulp of the whole and crushed Cyprian carob:**

-As a general rule, as temperature of extraction increased as T.S.S. content and O.D. increased. In contrast, pH value decreased with the increase in degree of temperature.

-Maximum T.S.S. achieved for whole and crushed carob after first extraction trial at 100 °C were 24.83% and 22.50%, respectively, which represent a recovered T.S.S. (from the total contained in the starting pulp powder) of about 26.97% and 24.44%, respectively. The 2nd re-extraction added another 10.33% and 10.0%, which represents 11.22% and 10.86%,

respectively, of the total solids contained in carob pulps. After three successive re-extraction trials, the maximum cumulative extraction reached 40.33% and 36.50%, respectively, which represents 43.81% and 39.66%, respectively, of the total solids contained in carob pulps.

- **Effect of extraction periods on extraction rate of whole and crushed carob pulp:**

-As duration of extraction increased as total soluble solids content and optical density increased. However, such increase was not pronounced with increasing period of extraction longer than 30 min. In contrast, pH value decreased with the increase in duration of extraction.

-The maximum T.S.S. and O.D. values of whole and crushed carob were achieved after extraction period for 120 min. in hot water. After the first extraction trial T.S.S. reached 25.00% and 24.50%, respectively, which represent a net recovered T.S.S. (from the total contained in the starting pulp powder) of about 27.16% and 26.62%, respectively. The 2nd re-extraction added another 12.00% and 11.50%, which represents 13.03% and 12.49%, respectively of the total solids contained in carob pulps.

-An optimum extraction period of only 30 min. at hot temperature condition of was selected as a compromise between speed of extraction and maximum extractability of components of the Cyprian carob of Tylliria variety.

- **Effect of pH medium on extraction rate of whole and crushed carob pulp of Tylliria variety:**

-Generally, as pH of extraction medium increased as total soluble solids content and optical density increased until pH 7 then decreased. However, such increase was not pronounced with increasing pH of extraction medium more than 7.

-With hot, semi-hot and room temperature conditions, the maximum T.S.S. was achieved when pH value of extraction medium was pH= 7.

- **Effect of different extraction conditions on sensory evaluation for carob extract.**

- The ANOVA analysis indicated that there were significant differences ($P \geq 0.05$) between the different treatments for the variable flotation ratios and conditions of extraction in all scores given for taste, odor, texture and overall acceptability. The highest scores were given to treatment of flotation ratio (2: 1) executed at hot condition, while the lowest were given to that treatment of flotation ratio (1 : 10) at room temperature.
- High significant differences ($P \geq 0.05$) existed between the treatments of different extraction periods and methods of extraction in all given scores. The highest scores were attained by treatment at hot condition for 30 min - High significant differences ($P \geq 0.05$) existed between treatments prepared under different degrees of hot temperatures in all given scores. The highest scores were attained by that treatment prepared at 100°C.

5. Survey study of carob beverage samples collected from some Egyptian local markets:

-The survey study employed 10 different samples, which were recognized as natural-made beverage, collected from different local markets from different places of Egypt.

-Total solids content ranged between 12.59 and 23.91%. Samples were characterized with a high content of total sugars, which ranged from 11.30 to 22.67%. Soluble reducing sugars content ranged from 0.78 to 1.81%, while non-reducing soluble sugars ranged from 10.39 to 21.00%. Ash content ranged from 0.07 to 0.23%. Titratable acidity content ranged from 0.02 to 0.09%, while pH value ranged from 4.52 to 5.77.

-The total microbial count present in carob survey samples ranged between $6.1x10^2$ c.f.u./ml and $9x10^6$ c.f.u./ml. Yeast and mold counts in ranged between $2.05x10^2$ to $5.05x10^5$ c.f.u./ml. *Sporformer bacteria* was not detected. However, *Staph.* count ranged between $7.75x10^2$ to $2.31x10^5$ c.f.u./ml. *Lactic acid*

bacteria count in carob beverage samples ranged from $4.35x10^2$ to $5.4x10^5$ c.f.u./ml. *Psychrophilic bacteria* count in carob beverage samples ranged from $5.65x10^2$ to $8.2x10^6$ c.f.u./ml. *Coliform bacteria* count ranged from $4.1x10^3$ to $3.6x10^5$ c.f.u./ml.

6. Essential minerals of carob pulp:

- Cyprian crushed carob sample contained higher mineral matter content than whole carob sample of the same variety. Generally, carob pulp proved to contain appreciable high amounts of potassium, calcium and magnesium. From the point of availability of macro-elements, they were ranked in a decreasing order of abundance as follows: potassium, calcium, magnesium, phosphorous and sodium. Potassium, which constituted the first major essential macro-elements ranged between 697.23 and 766.31 mg/100g. Calcium constituted the second major essential macro-elements where ranged between 312.14 and 384.26 mg/100g.

-Micro-elements detected in both carob samples tested were ranked, in a decreasing order of abundance, as follows: iron, zinc, copper and manganese. Iron constituted the first major essential micro-element, which ranged from 5.40 to 7.11 mg/100g, while zinc constituted the second major essential micro-element, which ranged from 0.26 to 0.43 mg/100g. Copper and manganese were not detected in both samples.

- The content of only 200g of carob could satisfy or cover most of the daily requirements (DR) for adult humans from calcium and the DR for children and adults from iron at 15% bioavailability ;1/2 the DR for adults from potassium and magnesium; 1/6 DR for children's from zinc and 1/16 the DR for adults from zinc at high bioavailability ; 1/11the DR from phosphorus as indicated by **WHO and FAO (2004).**

7. Study of volatiles components of carob pulp:

- Using the combined technique of gas chromatography-mass spectroscopy (GC-MS), 33 volatile components were

fractionated of which only 28 were identified in aroma concentrate of crushed carob of Tylliria variety. In order of decreasing abundance these identified volatiles were ranked as follows: hexanoic acid (45.74% of the total volatiles), propanoic acid (33.71%), octanoic acid (5.86%), isobutyric acid (5.81%), 1,2-benzenedicarboxylic acid (2.74%), Ethanone (0.78%), Heptanoic acid (0.35%), Methylamine (0.32%), Nonanoic acid (0.24%), Acetic acid (0.23%), Eugenol (0.22%), 4-Pentylbutan-4-olide (0.16%), Dibutyl phthalate (0.16%), Hexanoic anhydride (0.14), Butylated hydroxy toluene (0.14%), 9-Octadecenamide (0.14%), 2-Cyclohexen-1-one (0.11%), furfural (0.08%), 1-Hexadecane (0.08%), Decanoic acid (0.07%), Hexadecanamide (0.07%), 2H-pyran-2-one (0.06%), 7,9-di-tert-butyl-1-oxaspiro (0.05%), Tetradecane (0.04%), Hexadecanoic acid (0.04%), Hexadecane (0.03%) and Octadecane (0.03%). On the other hand, 32 volatile components were fractionated from aroma concentrate of the whole carob sample of which only 24 components were identified. Four components were missing from aroma profile of whole carob compared to that of crushed carob.