

Chemical Composition:

1 – Carbohydrates:

Fresh apples are considered a food of moderate energy value, whereas processed apple products are either comparable to fresh apples in energy value or higher because of concentration, dehydration, or the addition of sugars during processing. Chemical composition of apple is affected by many factors, including: (**cultivar, growing region, climate, maturity, cultural practices and processing**). Carbohydrates are the principal food constituents in apple, with starch and sugars the available carbohydrates and pectin, cellulose and hemicellulose the unavailable fractions. Total carbohydrates in fresh apples account for about 15%, comprising (0.89 – 5.58%) each of fructose and glucose; and (0.88 – 5.62%) sucrose.

Pectin is a mixture of water-soluble pectinic acid of varying methoxyl content and degree of neutralization that is capable of forming gels under suitable conditions of usually high sugar and acid content. Low-methoxyl pectin, with a low degree of esterification, is technologically important because of its ability to form gels without sugar in the presence of certain multivalent metallic ions (Ca^{2+}). The variation in pectin content is attributed to the maturity, cultivar and growing conditions.

2 – Organic acids:

Organic acids are among the most important constituents in apples. The primary acid in the fruit is malic although others such as citric, lactic and oxalic are also present. Various organic acids found in apple peel and pulp, though in smaller fractions, are presented in table (1).

The acidity in the fruit is of interest because it affects eating and cooking quality. The total acidity in apple juice in different varieties ranges from (0.22 to 0.78%), with an average of (0.42%) as malic acid. Similarly, the pH variation among cultivars ranged between (3.36 and 4.25).

3 – Proteins:

Fresh apples with skin contain about (0.19 %) protein, and as such are regarded as a poor source of this important nutrient. The proportion of

different amino acids (table 2) shows that aspartic and glutamic acid are the predominant amino acids in apples, followed by lysine and leucine.

Table (1): Organic acids found in apple fruit

Whole fruit or juice	Peel	Pulp
Malic	Glyoxylic	Pyruvic
----	Isocitric	----
Quinic	Malic	Malic
Glycolic	Citric	Citric
Succinic	Quinic	Quinic
Lactic	Shikimic	Shikimic
Galacturonic	Glycric	Citramalic
Citramalic	α – oxoglutaric	Glycric
Mucic	Pyruvic	α – oxoglutaric

Table (2): Amino acid content of fresh apple

Amino acid	(%)	Amino acid	(%)
Alanine	0.007	Lysine	0.012
Arginine	0.006	Methionine	0.002
Aspartic acid	0.034	Phenylalanine	0.005
Cysteine	0.003	Proline	0.002
Glutamic acid	0.020	Serine	0.006
Glycine	0.008	Threonine	0.007
Histidine	0.003	Tryptophan	0.002
Isoleucine	0.008	Tyrosine	0.004
Leucine	0.012	Valine	0.009

4 – Minerals:

Fresh apples content (0.26 %) ash contents, while in dehydrated apples it is 4 – 5 times higher, owing mainly to the effect of concentration. Some scientist reported some variations in ash content among apples from different geographic regions. This variability is assumed to be due to the availability of different minerals in the soils of different regions. Data on the concentrations of specific minerals found in apples are presented in table (3). Potassium constitutes the main portion of the total mineral contents of apples, and it accounts for more than (40 %) of the total ash.

Phosphorus and calcium are the next most prevalent mineral in the apple fruit.

Table (3): Mineral elements in fresh apples

Mineral	(ppm)	Mineral	(ppm)
Calcium	70.0	Chloride	4.2 – 6.2
Iron	1.8	Chromium	0.03
Magnesium	50.0	Cobalt	0.10
Phosphors	70.0	Copper	0.45
Potassium	1150.0	Iodine	0.02
Zinc	0.4	Molybdenum	0.30
Copper	0.4	Selenium	0.9 – 1.6
Manganese	0.4	Sodium	8.9 – 9.2

5 – Vitamins:

The vitamin contents of fresh apple are presented in table (4). The average ascorbic acid content is about (5 mg/100g) of apple. In comparison with the recommended daily intake of vitamins, the proportion of all other vitamins except vitamin C in apple was found to be insignificant.

Table (4): vitamin content of fresh apples per 100g of tissue

Vitamin	Concentration
Ascorbic acid (mg)	5.7
Thiamin (mg)	0.017
Riboflavin (mg)	0.014
Niacin (mg)	0.077
Pantothenic acid (mg)	0.061
Vitamin B ₆ (mg)	0.048
Folacin (mcg)	2.8
Vitamin A (retinol equivalent)	5.3

6 - Phenolic compounds:

Apple content several classes of phenolic compounds, including; hydroxycinnamic derivatives, flavonols, anthocyanin, dihydrochalcones, monomeric flavan-3-ols and tannins.