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DRY DATES POWDER INCORPORATED WITH VITAMIN C

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Abstract - Dates palm (*Phoenix dactylifera L.*) is an important crop which is cultivated in the warmer regions of the world. Semi-dry Aseel variety of dates is an important commercial variety of Pakistan which appears as yellow or golden colour. The iron content of aseel variety is 1.58 ± 0.04 mg/100g. Vitamin C sources such as lemon peel and aonla powders used for formulating the product. Iron and Vitamin C combine to form an iron chelate complex which increases the solubility of iron. However, an excess of 200 mg of Vitamin C per 30 mg of elemental iron is required to enhance the absorption of highly available iron salts, such as ferrous sulphate. The aim of this study is to increase the bioavailability of iron in human metabolism. The drying characteristics of dry dates (TD, 60°C), lemon peel and aonla (TD, 60°C and HAO, 60°C) were observed. The proximate composition of the formulated samples were determined. The ascorbic acid content of the formulated samples T₁ (58 mg/100 g), T₂ (62.3 mg/100 g), T₃ (450 mg/ 100 g) and T₄ (468 mg/100 g) were found. Desired ranges of these quality parameters of the formulated samples were fixed and selected as the best product.

Keywords – Dry dates, Iron absorption, Vitamin C, Lemon peel, Aonla

I. INTRODUCTION

Dates palm (*Phoenix dactylifera L.*) is an important crop which is cultivated in the warmer regions of the world significantly in countries like Egypt, Saudi Arabia, Iran, Pakistan, UAE, Libya, Oman and are grown in the Middle East, North Africa, South Asia, and the United States. The major date palm varieties grown in the United States are Deglet Noor and Medjool. Ajwa date fruits are soft and dry, it is cultivated in the Al Madinah region of Western Saudi Arabia. The Ajwa date variety is well known for its medicinal value. Aseel, Karbalain, and Autakin varieties are highly grown in Pakistan. In 2020, 8,441.33 MT of dates were produced globally and 362,209.00 MT of dates were

imported to India (APEDA). Dates are economically high, because it is nutritive and energy providing food. Dates are consumed as a staple food in the Middle East region.

Date palm cultivars are classified into three main types based on their moisture content i.e., soft, semi dry and dry cultivars. Dry dates are dates without the moisture which make them look harder and shrivelled. In addition, they are excellent energy boosters and a powerhouse of vitamins and minerals that can help us regain good health. In our research work we used Aseel variety of dry dates (chuara) which appears as yellow or golden colour. This variety is the most important commercial variety of Pakistan. It comes under semi-dry variety with the suitable fruit size of 4.3 cm in length and 2.5 cm in diameter (Markhandet al. 2010). Aseel has sweet taste without scorch in the throat. The environmental conditions and soil types play a significant role in the functional properties of this variety of dates.

Aseel varieties produced from palm grown in eastern part of district i.e., near to small mountain range has low moisture content. Consequently, the shelf life of this fruit is longer when compared to the same variety in the rest of districts. These dry dates are loaded with nutritive ingredients like vitamins, calcium, fibre etc. Dry dates make the bones and teeth healthy. Chuara (dry dates) are rich in polyphenols, anti-oxidants and provides a wide range of health benefits like diabetes management, cancer prevention, better digestion, promote brain health, may promote natural labour, act as excellent natural sweetener etc.

Aonla or Indian gooseberry (*Emblica officinalis Gaertn.*) is one of the richest source of Vitamin C. It contains 500 to 700 mg of ascorbic acid per 100 g of pulp, which is more than that available in other fruits. The aonla fruit is one of the most important ingredients used from ancient times in ayurveda for the successful treatments of several disease such as diabetes, cough, asthma, skin disease, inflammations, anemia, jaundice, diarrhea, dysentery, haemorrhages, cardiac disorders and greyness of hair. It is considered as a wonder fruit for health due to its unique qualities. Aonla contains leucoanthocyanin or polyphenols which retard the oxidation of vitamin C and presence of



astringency. Tannins contains gallic acid, elagic acid, and glucose which retard the oxidation of vitamin C and renders its value as antiscorbutic in the fresh as well as in dried conditions (Pareek and Kaushik, 2012). Aonla is also a source of carbohydrates, carotene, thiamine, riboflavin, and minerals like iron, calcium and phosphorus.

Lemon (*Citrus limon*) belong to family Rutaceae has global significance, one-third of their total produce is processed into different products, which results in the production of huge quantities of different by-products. Citrus fruits are rich sources of phytochemicals and various types of bioactive compounds, such as phenolic compounds, which have high antioxidant potential and other biological activities (Abou-Arab et al. 2016). The phenolic constituents of lemon depend on the soil varieties and the fruit part (peel, seed, and pulp). Lemon peel is generated as the primary by-product representing approximately 50 – 65% of the fruit weight. Peels are usually discarded causing environmental issues due to being prone to microbial spoilage. These peels are rich in fibre, Vitamin C, minerals etc, but it has strong taste so some processing is required to acquire its benefits. The citrus fruits are important sources of bioactive constituents carrying health potential.

Consumers have been encouraged to increase their daily intake of fruits and vegetables, dried fruits etc. When it comes to dry fruits, dry dates play a vital role as it has carbohydrates, iron, proteins, fat, fibre, minerals, vitamins, antioxidants, polyphenols, enzymes, organic acids etc. Even though dry dates contain many valuable substances it lacks Vitamin C.

Changes in food consumption can be noted in this decade. Consumers have been seeking healthier and more natural food stuffs in order to have balanced and nutritious diet. As a food technologist the main aim of this research work is to give a better alternative health powder using dry dates as a main ingredient incorporated with Vitamin C. Iron and Vitamin C combine to form an iron chelate complex which increases the solubility of iron. However, an excess of 200 mg of Vitamin C per 30 mg of elemental iron is required to enhance the absorption of highly available iron salts, such as ferrous sulphate. Thus, to increase the bioavailability of iron, lemon peel and aonla powders (the sources of Vitamin C) can be incorporated to dry dates powder which can be served to targeted community.

The present research work was designed and developed to incorporate dry-dates powder with Vitamin C. Therefore, the specific objectives of the present paper were followed,

Objectives

1. To study semi-dry dates (Aseel variety), Lemon peel and Aonla using different drying techniques.
2. To formulate dry dates powder with Vitamin C (lemon peel powder and aonla powder) at different ratios.
3. To analyse the ascorbic acid content and the proximate compositions of the formulated samples.

II. MATERIALS AND METHODS

A. Procurement of Raw Materials

The following ingredients were used during the preparation of dry dates powder incorporated with Vitamin C.

Semi-dry Dates

Semi-dry Aseel dates which were imported from Pakistan were acquired from the market in Tuticorin.

Lemon Peel

Fresh Lemon (*Citrus limon*) fruits were bought from the local market. The fruits were selected based on the size and yellow color. Before processing each fruit was washed by tap water then peeling was done manually.

Aonla

Fresh Aonla or Indian gooseberry (*Emblica officinalis* Gaertn.) fruits were purchased from the local market. Fruits having crack or skin injuries and specks were rejected.

B. Processing Techniques

Drying of Semi-dry Dates

The fresh semi-dry dates were sliced and de-seeded in the laboratory for the experiment. These sliced portions are arranged in trays and it was dried using two different drying techniques such as solar drying ($45^{\circ}\text{C} \pm 5^{\circ}\text{C}$) and tray drying (60°C). The flowchart for preparation of dry date powder was shown in Fig. 1.

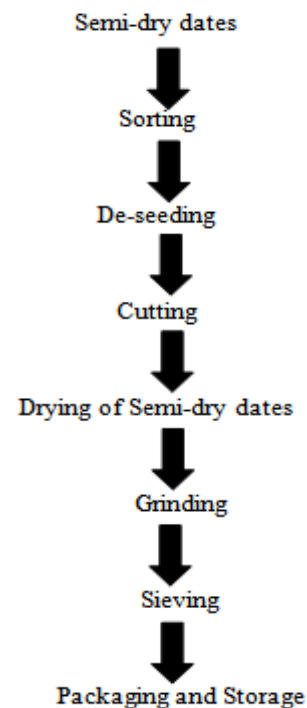


Fig. 1. Flow chart for preparation of dry-dates powder

Drying of Lemon Peel

The fresh lemon fruits were washed in portable water, peeled and their edible portions were carefully separated. The obtained fresh lemon peels were cut into small pieces before the drying process. The drying was carried out using four different techniques such as solar drying ($45^{\circ}\text{C} \pm 5^{\circ}\text{C}$), tray drying (40°C , 60°C), hot air oven drying (40°C , 60°C) and vacuum oven drying (500mm Hg , 60°C). The flowchart for the preparation of lemon peel powder was shown in Fig. 2.

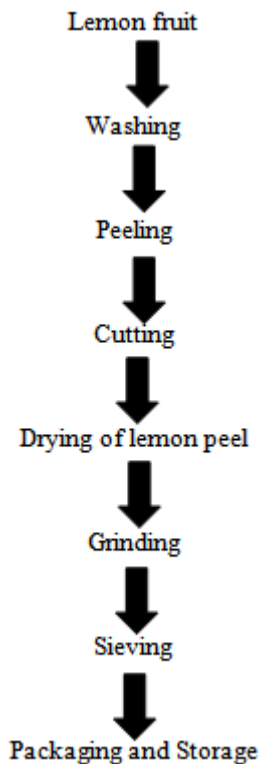


Fig. 2. Flow chart for preparation of lemon peel powder

Drying of Aonla

The fresh fruits were washed. The flesh portion was sliced and de-seeded. After that the slices are dried using different drying techniques such as solar drying ($45^{\circ}\text{C} \pm 5^{\circ}\text{C}$), tray drying (40°C , 60°C), hot air oven drying (40°C , 60°C) and vacuum oven drying (500mm Hg , 60°C). The flowchart for the preparation of aonla powder was shown in Fig. 3.

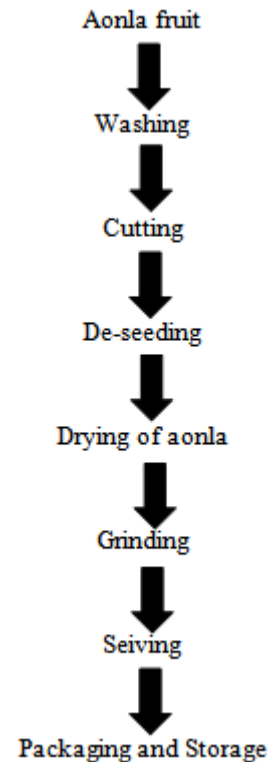


Fig. 3. Flow chart for preparation of aonla powder

C. Drying Techniques

Solar Dryer

The solar dryer available in CFNFT, invented by the final year students (2018 batch) of B. Tech Food Technology was used for drying of semi-dry dates, lemon peel and aonla. The drying time varies from 22 to 24 hrs based on the variety of samples. Drying continues until constant weight reaches. The temperature is maintained at $45^{\circ}\text{C} \pm 5^{\circ}\text{C}$.

Tray Dryer

The tray dryer available in CFNFT, Chennai was used for drying of semi-dry dates, lemon peel and aonla. The drying temperature of the above samples was maintained at 40°C and 60°C respectively. The drying time varies from 24 to 72 hrs based on the samples. The drying process continues until constant weight reaches.

Hot Air Oven

The hot air oven drying was done using laboratory scale drier and the drying was carried at different temperatures at 40°C and 60°C for semi-dry dates, lemon peel and aonla. The drying time varies from 24 to 72 hrs based on the type of samples.

Vacuum Oven

The vacuum (500 mmHg) drying was done using a laboratory drier with vacuum pump. The drying was carried



at the temperature of 60°C for lemon peel and aonla. The drying time varies from 22 to 24 hrs based on samples.

D. Grinding of Dried Samples

Immediately after termination of the drying operation the dried samples (dry dates, lemon peel, aonla) was placed in desiccators. Then the samples were cooled at room temperature and ground in domestic kitchen mixer for the preparation of powder.

E. Packaging of Dried Samples

For the packaging of dried and formulated samples, the important consideration is protection from moisture pickup, oxidation and loss of volatile flavouring constituents. Exposure to light and high temperature may leads to the oxidation of Vitamin-C. If the products are packed in flexible packages having resistance to water vapour, it prevents mould growth. For packaging of the dried samples Aluminium foil and LDPE are used. These can preferably pack under nitrogen, as they are susceptible to oxygen.

F. Storage of Dried Samples

Shelf life is the length of time that a commodity may be stored without becoming unfit for use, consumption, or sale. Environmental factors affecting food stability includes humidity, oxygen, toxic vapours, physical contamination, light, time, temperature and history of package. These dried samples were stored at ambient temperature.

G. Formulation of Dry-dates Powder with Vitamin-C

The tray dried (60°C) dry-dates powder was formulated with Vitamin C from tray dried (60°C) lemon peel powder and tray dried (60°C) aonla powder in two different concentrations each. 75 g of dry-dates powder was formulated with 1 g and 2 g of lemon peel powder and aonla powder. The following are the control and the formulated samples

T₀- Control sample (dry-dates powder)

T₁- 75 g of dry-dates powder formulated with 1 g of lemon peel powder.

T₂- 75 g of dry-dates powder formulated with 2 g of lemon peel powder.

T₃- 75 g of dry-dates powder formulated with 1 g of aonla powder.

T₄- 75 g of dry-dates powder formulated with 2 g of aonla powder.

H. Analysis of Ascorbic Acid

Sample Preparation

0.5g of dry powders (lemon peel, aonla) are mixed with 4% oxalic acid solution and make up to a known volume of 100ml.

Method of Titration: The 2,6-dichloroindophenol (dye) titrimetric method, (Sadasiyam et al. 2018) was used to determine the Vitamin C content of lemon peel and aonla

powder. The powdered samples were blended with oxalic acid solutions. After that the sample is centrifuged, the supernatant in addition to 4 % oxalic acid is titrated against the dye. Results are expressed in mg ascorbic acid/100g of sample.

$$\text{Amount of ascorbic acid} \frac{\text{mg}}{100 \text{ g}} \text{ sample} = \frac{0.5 \text{ mg}}{V_{1 \text{ ml}}} \times \frac{V_2}{5 \text{ ml}} \times \frac{100 \text{ ml}}{\text{Wt. of the sample}} \times 100 \text{ ---- (1)}$$

Where,

V₁ – Titre Value (Working Standard)

V₂ – Titre Value (Sample)

I. Proximate Analysis

Moisture Content

Semi-dry dates, lemon peel and aonla pulp was analysed for moisture content determination following AOAC (2006) method. Purposely 3 g of the above samples was dried in hot air oven at 105±5°C temperature until constant weight.

$$\text{Moisture (\%)} = \frac{\text{Wt. of fresh samples (g)} - \text{wt. of dried sample (g)}}{\text{wt. of fresh sample}} \times 100 \text{ ----- (2)}$$

Crude Protein Content

Kel Plus apparatus (KEL VAC, 230V AC, 50 Hz) was used to measure the percent nitrogen in dry dates (control) and other formulated samples according to the AOAC (2006) method. Here, 1 g of each sample was digested using concentrated H₂SO₄ (20 ml) along with the digestion tablet (K₂SO₄:CuSO₄ : 9:1) until the colour was light greenish (3 to 4 hrs). The digested sample was then added to 250ml volumetric flask and volume was made up to the mark using distilled water. Afterwards, 10 ml of 40% NaOH and 10 ml digested sample were taken in the distillation apparatus, where the liberated ammonia was added to the flask containing 4% solution of boric acid and one to two drops of methyl red indicator. This lead to the ammonium borate formation which was then used for the determination of nitrogen in the sample. The nitrogen percentage in the dates and other formulated samples was assessed by titrating the distillate against 0.1 N solution of H₂SO₄ till the appearance of light golden colour. The crude protein content was determined by multiplying the nitrogen percentage with the factor 5.80.

$$\text{Nitrogen (\%)} = \frac{\text{Volume of 0.1N sulphuric acid used} \times 0.0014 \times 250}{\text{wt. of sample} \times \text{Aliquot volume}} \times 100 \text{ ----- (3)}$$

$$\text{Crude protein (\%)} = \text{Nitrogen (\%)} \times 5.80 \text{ ----- (4)}$$



Crude Fat

Socs Plus (SCS 04 AS DLS TS) apparatus was used to determine the fat content in dry dates and other formulated powders following AOAC (2006) method. For this, 1 g of moisture free sample was weighed and taken in a thimble. Then 50ml petroleum ether as a solvent was added into the flask then was added to the Soxhlet (extraction unit). Fat content in the samples was extracted for 2-3 hrs in the Soxhlet by regulating the flow rate of 3-4 drops per second of petroleum ether. After extraction, the thimble was removed and dried in a hot air oven at constant temperature (105°C) for constant time (1 hr) and then weighed using weighing balance.

$$\text{Crude fat (\%)} = \frac{\text{wt.of petroleum ether extract (g)}}{\text{wt.of the sample}} \times 100 \text{ ----- (5)}$$

Crude Fibre

The fibre content of dry dates and other formulated samples was determined using Fibra Plus (FES 04 AS DLS TS) apparatus (Plate 3.9) by following AOAC (2006) method. Here, 1 g of defatted samples was digested using 1.25% of boiling H₂SO₄ (200ml) for 30 minutes in the fibra plus apparatus. H₂SO₄ was drained out and the digested sample was then filtered and washed three times using boiling distilled water to ensure acid free sample. Afterwards, it was again digested for 30 minutes in 20 ml boiling NaOH (1.25%). The NaOH was then drained out and the digested

sample was again filtered and washed three times with boiling distilled water to make free from alkaline residues. The residues obtained was then dried at constant temperature and time (130°C & 2 hrs) and weighed (w1). The oven dried samples were ignited in the muffle furnace at temperature of 550°C to 650°C till white ash was obtained and then it is weighed (w2).

$$\text{Crude fibre (\%)} = \frac{w1-w2}{\text{wt.of the sample (g)}} \times 100 \text{ ----- (6)}$$

Ash Content

The ash content was determined by incineration of the sample following the AOAC (2006) procedure. Accordingly, 3 g sample was taken in a crucible and kept in muffle furnace at the temperature of 550°C to 600°C for about 5-6 hrs till greyish white residue was obtained.

$$\text{Ash (\%)} = \frac{\text{wt.of ash (g)}}{\text{wt.of sample (g)}} \times 100 \text{ ----- (7)}$$

III. EXPERIMENT AND RESULT

A. Drying characteristics

The drying characteristics of dry dates (TD, 60°C), lemon peel (TD, 60°C and HAO, 60°C) and aonla (TD, 60°C and HAO, 60°C) is given in Fig. 4, 5 and 6 respectively. From this figure it is observed that the moisture content decreases with increase in time.

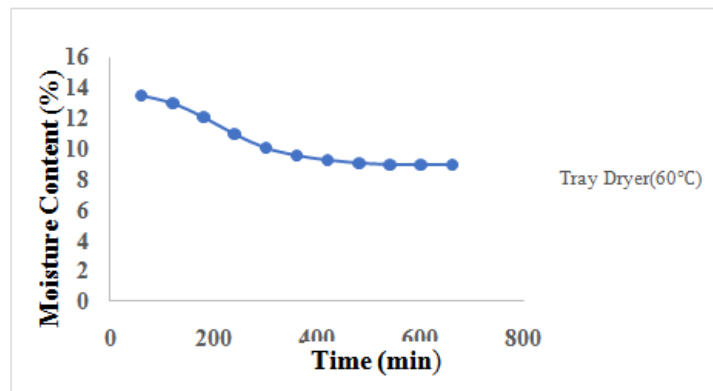


Fig. 4. Semi-dry Dates dried in Tray dryer at 60°C

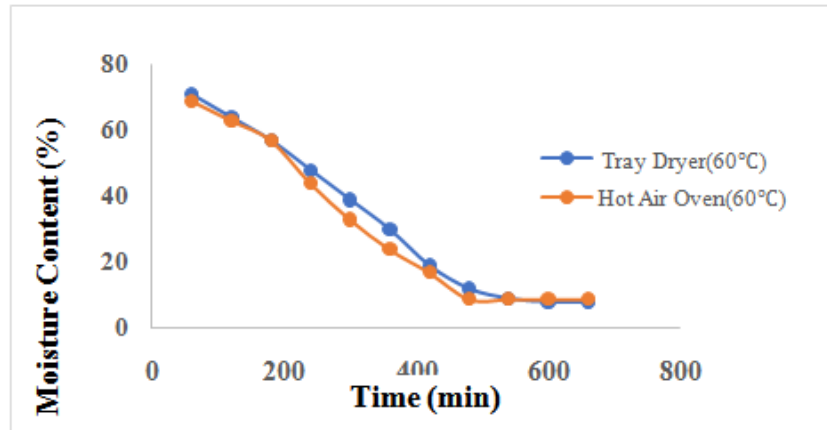


Fig. 5. Lemon peel dried in Tray dryer and Hot air oven at 60°C

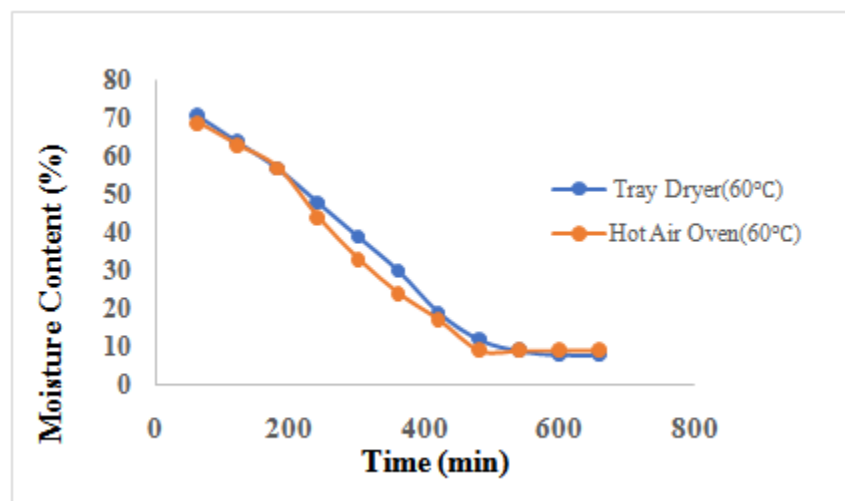


Fig. 6. Aonla dried in Tray dryer and Hot air oven at 60°C

B. Ascorbic Acid Content

The ascorbic acid content of T₀ (control) and the formulated samples T₁, T₂, T₃ and T₄ were ND, 58, 62.3, 450 and 468 mg/100 g respectively. As reported by Hinkaewet al. (2021) the Vitamin C content is not detected in date fruits. But, as a result of incorporation of Vitamin C sources, the ascorbic acid content was detected in the formulated samples.

Table - 1 Ascorbic acid content of the formulated samples

Samples	Ascorbic Acid (mg/ 100 g)
T ₀	Nil
T ₁	58
T ₂	62.3
T ₃	450
T ₄	468

C. Proximate Analysis

The proximate composition such as moisture content, crude protein, crude fat, crude fibre, total ash content of T₀ (control) and the formulated samples T₁, T₂, T₃, T₄ were analysed and their values were depicted in the Table 2.



Moisture Content

The moisture content of T₀ (control) and the formulated samples T₁, T₂, T₃ and T₄ were 8.8±0.02, 3.39±0.03, 3.4±0.03, 4.3±0.02 and 4.5±0.03 respectively. The result obtained were comparatively lower than the values obtained for dates powder by Alruqaie and Al-Ghamidi (2013).

Crude Protein

The crude protein of T₀ (control) and the formulated samples T₁, T₂, T₃ and T₄ were 5.6±0.01, 3.38±0.00, 4.39±0.01, 4.06±0.01 and 4.03±0.02 respectively. The percent would vary depends on the drying techniques. The result obtained were comparatively higher than the values obtained by Sohailet al. (2019).

Crude Fat

The crude fat of T₀ (control) and the formulated samples T₁, T₂, T₃ and T₄ were 2.1±0.14, 1.5±0.14, 5.5±0.14, 2±0.14 and

6.5±0.14 respectively. The fat content varies depends on the drying techniques of semi-dry dates and the incorporated Vitamin C sources. The result obtained were higher as compared to Khadijatet al. (2019).

Crude Fibre

The crude fibre of T₀ (control) and the formulated samples T₁, T₂, T₃ and T₄ were 4.84±0.17, 3.5±0.23, 5±0.21, 3±0.21 and 6±0.14 respectively. The fibre content may vary depends on the drying techniques of semi-dry dates and the incorporated Vitamin C sources. The results obtained were higher as compared to those obtained by Awan et al. (2018).

Total Ash Content

The total ash content of T₀ (control) and the formulated samples T₁, T₂, T₃ and T₄ were 0.94±0.03, 2.66±0.01, 1.33±0.02, 0.6±0.17 and 2.33±0.02 respectively. The results were similar to those obtained by Hariri et al. (2018).

Table - 2 Proximate composition of the formulated samples

Samples	Moisture Content (%)	Crude Protein (%)	Crude Fat (%)	Crude Fibre (%)	TotalAsh Content (%)
T ₀	8.8±0.02	5.6±0.01	2.1±0.14	4.84±0.17	0.94±0.03
T ₁	3.39±0.03	3.38±0.00	1.5±0.14	3.5±0.23	2.66±0.01
T ₂	3.4±0.03	4.39±0.01	5.5±0.14	5±0.21	1.33±0.02
T ₃	4.3±0.02	4.06±0.01	2±0.14	3±0.21	1.6±0.17
T ₄	4.5±0.03	4.03±0.02	6.5±0.14	6±0.14	2.33±0.02

IV. CONCLUSION

Now-a-days, iron deficiency is one of the most prevalent and potentially serious forms of nutrient deficiency. Low intake of iron accounts for anaemia in developed and non-industrialized nations. The main reason for the lack of adequate iron absorption is that upon exposure to oxygen, iron form highly insoluble oxides which are unavailable for absorption in the human gastrointestinal tract. In attempting to combat iron deficiency, the nonheme iron is highly focused, which makes up over 90 % of iron in an average diet. Ascorbic acid is a powerful enhancer of nonheme iron absorption. It captures nonheme iron and stores it in a form that is more easily absorbed by the human body.

For the present study different sources of Vitamin C such as lemon peel and aonla were selected and incorporated in dry-dates powder to increase the bioavailability of iron in human metabolism.

In this paper, the drying characteristics of the dry-dates, lemon peel and aonla were studied using different drying techniques. The ascorbic acid content of the control and the formulated samples were determined using standard procedures. The proximate composition of the control and the formulated samples such as moisture content, crude protein, crude fat, crude fibre and total ash content were determined by AOAC (2006) method.

Drying is the important post-harvest operations among hot-air method of drying is one of the most widely used one for preservation of food in commercial processing. Semi-dry dates are tray dried at 60°C, lemon peel and aonla are tray dried and hot air oven dried at 40°C and 60°C. The tray dried and hot air oven dried powders at 40°C drying temperature found the highest ascorbic acid content followed by 60°C. Drying tends to decrease a_w of the products, inhibiting development of micro-organisms and decreasing spoilage reactions to prolong the shelf life.



Added advantages of dehydrated products include reduction in cost of packaging, storage and transportation due to reduced bulk and mass of the dried products.

The ascorbic acid content of the formulated samples T₁ (58 mg/100 g), T₂ (62.3 mg/100 g), T₃ (450 mg/ 100 g) and T₄ (468 mg/100 g) were determined. From the result obtained the sample T₄ has the highest value of Vitamin C which can increase the absorption of iron when compared to other formulated samples. Proximate analysis of the formulated dry-dates powder showed differences in the crude protein, crude fat, crude fibre and total ash content. As a result, the formulated samples are nutrient rich.

Thus, we conclude that the Vitamin C incorporated dry-dates powder can be a supplement for targeted community (anaemic) in increasing the iron absorption. It can also be consumed by all age group of people because it is highly nutritious, energy boosting, an alternative for sugar and can be used in bakery and confectionery products. Currently, the Vitamin C incorporated dry-dates powder are unavailable in the market. Thus, by commercialising this product can create demand and increase the market value of the product. The efficiency of the product can be increased by incorporating the dry-dates powder with concentrated form of ascorbic acid.

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