

Estimation of Beta-Carotene from Vegetables using Chemical and Hyperspectral Remote Sensing Approaches

¹Shrikant B. Bhosale,²Amarsinh B. Varpe

¹Department of Botany, ²Department of Computer Science
Shikshan Maharashi Dnyandeo Mohekar Mahavidyalaya, Kalamb, Dist.Osamanbad, (M.S) India

Abstract—The B-carotene value of vegetables was evaluated using chemical analysis and hyperspectral remote sensing data methods. The computational results were validated via chemical analysis methods. The evaluation of vegetables composition of Jelly chocolate was carried out using chemical produces which was tedious and required long time. The spectra of vegetables were acquired by ASD spectroradiometer. The chemical extraction was performed and the spectra of vegetables were acquired by ASD spectroradiometer. The term Beta-carotene is used for several related substances having the formula C₄₀H₅₆ which are synthesized by plants but cannot be made by animals. Carotene is an orange photosynthetic pigment important for photosynthesis. Carotenes are responsible for the orange color of the carrot and many other fruits and vegetables. Beta-carotene is composed of two retinol groups, and is broken down in the mucosa of the small intestine by Beta-carotene deoxygenase to retinal, a form of vitamin A. These vegetables contains chiefly Beta-carotene which is precursor of Vitamin-A. Vitamin A deficiency and mal-nutrition especially in child. Due to the lack of Awareness, Improper processing of vegetables, Low keeping quality, Lack of refrigerators, Lack of electricity. Waste vegetables are the major problem for rural area. Waste vegetables contain sufficient quantities of Beta-carotenes. The computed model was based on a correlation study between reflected spectra and vegetables contents. Waste vegetables collected from market and Beta-carotene estimated by column chromatography technique. Estimated Beta carotene was used in fruit jelly chocolate for child nutrition to avoid Vitamin A deficiency.

IndexTerms—Beta-carotene, Vegetables, hyperspectral image, column chromatography, Jelly chocolate, Vitamin A.

I. INTRODUCTION:

Human body requires vegetables like Spanich, Fenugreek, Dill, Coriander, Mint, Onion and Cauliflower such as B-Carotene sources. Similarly, human beings require a number of complex organic compounds as added caloric requirements to meet the need for their muscular activities [1]. Obviously, human food is mostly derived from plant sources. Amongst, the vegetables sources, seed are one of those which contain a variety of important B-Carotene compositions.

Beta-Carotene was first isolated by “Wackenroder” in 1831. Beta-Carotene belongs to group of more than 600 compounds. Jointly called as carotenoids. It has numerous biological functions in the human body and because human is not able to synthesize any of them. It is necessary to supply these valuable compounds with food or pharmaceuticals [2],[3]. Beta-Carotene is one of a group of orange and yellow pigments called carotenoids. Beta-carotene genuine extremely colored (red, orange, yellow), fat-soluble pigments naturally gift in several fruits, grains, oils, vegetables and in each leaf wherever they're covered by pigments. Beta-carotene is pre cursor of vitamin 'A' is an essential amino acid. Once temperature falls in season, pigment is demolished and also the lovely carotenoids colors seem [4]. It is antioxidant actively which helps to protect cells from damage. Among the present carotenoids which will be born-again to xerophthol within the physical body, supposed 'pro-vitamin A carotenoids', carotenoid is that the most copious and best one found in foods [5].

Beta-carotene has been associated with a decreased risk of lung cancer in people who smoking cigar. In lung cancer in the group receiving 20 mg of Beta-carotene a day 5 to 8 years it may be decreasing the risk of cancer such as Breast cancer, Asthma Ovarian cancer, Complications post-childbirth, diarrhea, fever post-childbirth, Alzheimer's disease etc. Vitamin A is essential for normal development, growth and eyesight [6]. Thus, dietary Beta-carotene is essential for most people. Sensible vision of eye is health, influential system and healthy skin and inhibitor, contributory to protective the body against the damaging effects of free radicals. Individuals with 'erythro poietic protoporphyria', a rare genetic condition that causes painful sun sensitivity, square measure typically treated with high dose carotenoid to cut back sun sensitivity [7],[8].

Oral supplementation of carotenoid has been used with success as sun protection together with sunscreens within the hindrance of sunburn and high doses of carotenoid might decrease sensitivity to the sun [9]. Beta-carotene nature identical is a food colorant fixing type, broadly utilized in Juice, Jelly Candy, Baked Goods, Savory, Beverage, Bakery Mixes, Ice Cream, Chocolate and Hard Candy. It is esteemed as a food colorant [10]. We source Beta-carotene nature identical from believed provides situated in India. Vitamin A can be safely provided to children in a large dose, rather than more frequent smaller doses in the form of Jelly chocolate.

Beta-carotene jelly chocolate is an easier and cost reducing method for children feed in developing country such as India from waste vegetables. Waste vegetables are the major problem in some region of India due to no awareness to recycling methods [11].

In the present study, the two datasets like chemical analysis and ASD data were used for the estimation of Beta-carotene content of Jelly. The study of chemical lab and spectral measurements extraction were carried out in the range 400 nm to 1000 nm. The

present paper is divided in four sections. The section first reveals an introduction and the challenges of related study with improvement of hyperspectral remote sensing data and background study.

II. MATERIALS AND METHODS:

Isolation of Beta-Carotene from vegetables:

Take 200 gm of vegetable leaves and crush with the help of normal and pestle with adding 80 % acetone make fine paste. Seueeze the sample by four folded muslin cloth in beaker then make volume 100 ml of the sample by adding acetone and take a sample in conical flask. Pass the sample through anhydrous sodium sulphate.



Figure.1 Beta-carotene isolation from vegetable

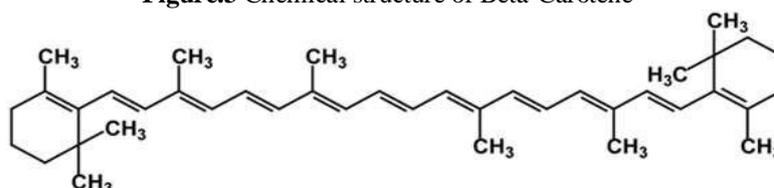
Column Chromatography:

Set up the column with clamp column filled by silica get. Sample introduced in the column and passed over column with 30 % n-hexane and ethyl acetate. When solvent system passes through silica column initially Beta-carotene separates out as orange color collected fractions of Beta-carotene.



Figure.2 Column chromatography

Figure.3 Chemical structure of Beta-Carotene



Instrumentation and Measurement:

Spectral signatures were taken using Field Spec 4 (Analytical Spectral Devices, Boulder, CO, USA) high-resolution field portable spectroradiometer with spectral range located in the VIS, NIR and SWIR region (350 nm-2500 nm). Instrument sampling intervals of ASD are (1.4 nm and 2 nm) with the 1 nm linear spacing interval. All the spectral responses were collected under the 45 degree and Field of View (FOV) lamp angle. Tungsten halogen quartz lamp with 1,000 watts under the standard darkroom-controlled condition. White reference panel measurements were collected to the standardized instrument and calibrate for database collection. The spectral responses were collected throughout experiment between 11.30 a.m. and 2.00 p.m. to avoid bidirectional reflections. Each reflectance curve was measured as an average of 10 spectral measurements with slightly varying locations of samples [12]. The 80 FOV along with fiber optic cable is used for spectra collection using RS3 which is in-built software tool calibrated with the instrument. The following Fig. 1 provides the leaf samples and generated spectral response curve ranging from 350 nm-2500 nm using spectroradiometer in a closed indoor environment. The spectra were collected in crop growth stages including healthy leaves, diseased leaves and dry leaves for water contents estimation. The x-axis represents wavelength spectrum and the y-axis represents reflectance of observed samples [13].

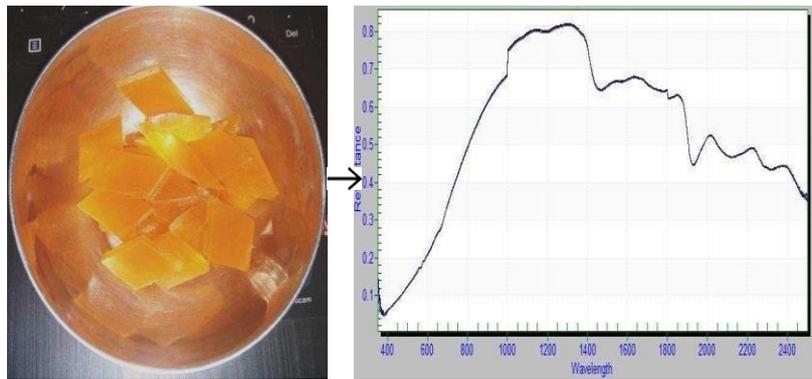


Figure.4 Spectral response curve of Beta-Carotene Jelly

III. PROPOSED METHODOLOGY:

Beta Carotene Jelly Chocolates:

The cutting samples in 250 gm guava in small pieces and boil in water for 15 minutes. After boiling mash well and drain with double folded muslin cloth and take the guava juice and boil. Material add sugar, 100 gm, 20 gm agar agar powder, 5 ml of Beta-carotene in it. Keep in refrigerator for set jelly Beta-carotene jelly chocolates are ready to eat.

Table.1 Beta-carotene content (pg/200g) different fresh vegetables

Sr No.	Botanical Name	Local Name	Sample	ml/200g
1	Spanaciaoleracea	Palak	Spanich	26.20
2	Trigonella spp.	Methi	Fenugreek	25.00
3	Anethum graveolens	ShepPu	Dill	25.00
4	Coriandrum sativum	Kothimbir	Coriander	21.00
5	Menthe viridus	Pudina	Mint	20.50
6	Allium cepa	Kanda	Onion	15.00
7	Brasicaa	Kobi	Cauliflower	10.40

Spectral Vegetation Indices (SVIs):

Spectral vegetation indices have been amplitude from strongly spectral data which are closely correlated to specific jelly parameters e.g., Beta-Carotene. SVI are idely applied in hyperspectral remote sensing data for the identification.

Pigment specific normalized difference (PSND):

The indices may provide a mesasure of the depth of the pigment absorption features in leaves relative to the highly reflective near infrared, palling these indices to the present data set we find that strong exponential relations exist between Carotenoids. The formula of indices eq.1 uses Carotenoids content for four different wavelengths such as 470 nm, 635 nm, and 800 nm [14].

$$PSNDc = (R_{800} - R_{470}) / (R_{800} + R_{470}) \quad (1)$$

Where, R is reflectance at the wavelength denoted by the subscripts.

Mean and Standard deviation:

The standard deviation is used to make estimates or inferences about the population standard deviation [15].

$$S = \sqrt{\frac{\sum (X - \bar{x})^2}{n - 1}} \quad (2)$$

Where, S is Standard deviation

∑ Sum of

X is each value, S Sample mean,

n Number of values in the sample

IV. RESULTS AND DISCUSSION:

In our study, we have used chemical methods and remote sensing method by computed Beta- Carotene content extracted. Beta-carotene plays important role in photosynthesis such as trap the light energy and converted into chemical energy. Beta-carotene in small amount is very useful for humans especially important for skin and hair growth. We are selected 5 waste vegetables fenugreek, Dill, Spinach, coriander and spinach. We also isolate Beta-carotene from five vegetables in good amount. We collect Beta- carotene and use it to making jelly chocolates. Beta-carotene may be also used in juice, jelly candy, bakery mixes, Ice cream, and Hard candy. We should use it in industries of foods. Use of Beta-carotene has been associated with and decreased risk of lung cancer in people who smoke. It is listed as vitamin 'A' on the supplement label because the body can convert it into that vitamin. It is also useful in preventing retinoblastoma which is special type eye cancer in child. It helps to avoid spectacles. Beta-carotene in food may help prevent some cancers. It works as an antioxidant protects the body from free radicals. It also prevents diseases such as breast cancer, asthma attacks, ovarian cancer, Alzheimer's disease, cataracts etc.



Figure.5 Beta-Carotene jelly chocolates

The statistics of the samples value of Beta-Carotene studied under laboratory conditions. The descriptive statistics of Beta-Carotene derived from hyperspectral non-imaging data shown in table.

Table.2 Statistical summary of the Beta-Carotene analyzed using conventional methods

Samples	Min	Max	Mean	STD
Alak	0.62	0.65	0.62	0.005
Ethi	0.61	0.62	0.61	0.004
Sheppu	0.22	0.23	0.23	0.009
Kothimbir	0.19	0.20	0.19	0.009
Pudina	0.44	0.46	0.44	0.009
Kanda	0.59	0.61	0.59	0.004
Kobi	0.24	0.25	0.25	0.001

The statistics of the vegetables Cars values of the processed vegetables specimens studied under laboratory conditions are given in table.2. The descriptive statistics of vegetables contents derived from hyperspectral non-imaging data are shown in table.2. The alak contents ranged from (0.62) to (0.65) the highest value was (0.62). The sheppu values ranged from (0.61) to (0.62) which mean more vegetables were having value (0.61) which indicated that the powder from the studied vegetables. Kothimbir min (0.19) and max (0.20) value the mean are (0.19). Vegetables pudina extracted Beta-Carotene content (0.44) and (0.46) highest value is (0.44). The Care content are extracted (0.59) to (0.61) having (0.59). Kobi was and max (0.24) to (0.25) the highest value is (0.25).

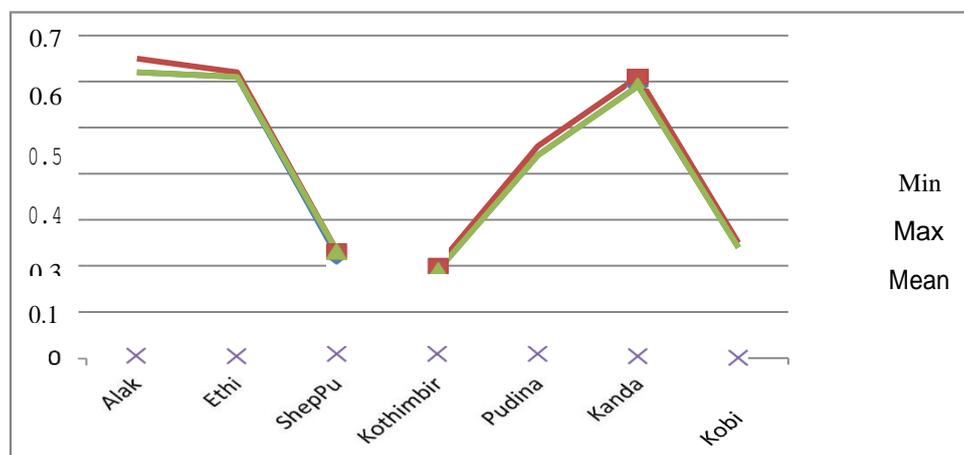


Figure.6 Mean and standard deviation of Beta-Carotene attributes

V. CONCLUSION AND FUTURE SCOPE:

The feasibility of vegetables components using chemical analysis and hyperspectral non-imaging combined with different preprocessing methods were calculated. It is concluded that the vegetables contents can be detected successfully by the data samples chemical techniques and ASD methods at wavelength. Beta-carotene is made out of two retinol groups, and is separated in the mucosa of the small digestive system by Beta-carotene deoxygenize to retinal, a type of nutrient A. Vegetables contains adequate amounts of Beta-carotenes. Vegetables gathered from market and Beta-carotene assessed by section chromatography technic. Beta carotene was use in natural product jelly chocolate for child nourishment to keep away from Nutrient an insufficiency. Vitamin 'A' can be securely given to kids in a huge portion, as opposed to more successive more modest dosages as jelly chocolate. Beta-carotene jelly chocolate a simpler and cost diminishing strategy for children feed in agricultural nation like India from vegetables. West vegetables are the serious issue in some district of India pair to no attention to processing strategies. Utilization of Beta carotene has been related with and decreased hazard of cellular breakdown in the lungs in individuals who smoke. It is recorded as Vitamin 'A' on the enhancement mark in light of the fact that the body can change over it into that nutrient. It is likewise helpful in forestalling retinoblastoma which is uncommon sort eye malignancy in kid. Beta-carotene in food might assist with forestalling a few malignant growths. It works a cancer prevention agent shields the body from free extremists. It additionally forestalls illnesses, for example, bosom malignant growth, asthma assaults, ovarian malignant growth, Alzheimer's infection. The present study can be used for vegetables Beta-Carotene Jelly Chocolates content within time which has useful applications in child nourishment to avoid Vitamin A deficiency.

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