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CONTENTS

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Editorial Note

In the last two decades India has experienced number of changes in the business and industrial environment. The New Reforms of 1991 has been able to provide a dynamic business environment that was lacking in the first five decades after independents. Accordingly new and hitherto unobserved business opportunities have emerged for budding entrepreneurs. The traditional and conventional business lines have taken a back seat. Sum of these emerging areas of business are outsourcing, consultancy, hospitality, tourism and others.

The Food Technology, Management and Food Services Sector also are under this important emerging area. Late Prof. Dr. A. D. Shinde, The Founder Director of CSIBER Trust, realized the importance of this field way back in early eighties. To realize his dream he started the College of Non-Conventional and Vocational Courses for Women (CNCVCW) at Kolhapur. He introduced innovative courses especially for women. These courses are skill oriented and help the women to find suitable placement in Food, Fashion and Interior Designing fields. At the same time they are equipped and trained to start their own business and become a source of employment for others in the society.

As a part of the academic responsibility and make the stakeholders aware about the recent trends in the three sectors, the college regularly conducts seminars, workshops and conferences. This year the college conducted a National level conference on the Recent Trends in Food Technology and Management on 28th and 29th March 2014. The conference received overwhelming response. There were almost 35 participants from different parts of the country presenting their research papers on different sub themes of the conference. In the poster presentation category there were almost 15 participants displaying their ideas and innovations in the area of Food and Management.

The topics covered in the papers submitted for the conference dealt with innovations in Food Processing industry, Bio technological aspects, Legal environment for food industry and the management trends in the sector. The national conference was able to attract good research papers on different themes from participants hailing from various states of our country. In the present issue we publish selected research papers of the conference. These papers will serve as an academic input for all those scholars interested in this specialized and emerging area.

Dr. T. V. G. Sarma
Editor

Development of Lycopene Enriched Noodles

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Abstract: Present study focuses on development of lycopene incorporated noodles. The lycopene was extracted from tomato processing industry waste. The extracted lycopene was encapsulated by using sucrose and gelatin as carrier material. The encapsulation of lycopene was carried out by spray drying technique. The noodles were prepared with incorporation of free and encapsulated lycopene. The maximum degradation was occurred in noodle sample (38.8%) added with free lycopene whereas only 1.66% degradation was observed in the sample added with encapsulated lycopene. The sample added with encapsulated lycopene improves sensory attributes particularly sensory score for colour of noodles. Maximum sensory score for colour was scored by the sample added with microencapsulated lycopene was 8.5, whereas that of sample added with free lycopene was 8.3 and 8.0 for control sample. This indicated that the encapsulated sample was not influenced by the processing. This will explore new technique for stabilization of natural colornt.

Key Words: Lycopene, Noodle, encapsulation, tomato processing industry waste, extraction

1.0 INTRODUCTION

Lycopene is one of the most common carotenoids found in human serum and the predominant one found in plasma (Agarwal and Rao, 2000; Stahl and Sies, 1996). Due to the high number of conjugated double bonds, it is considered to be one of the most potent antioxidants among the carotenoids (Dimascio et al., 1989). The increase in the consumption of tomatoes and other products that contain lycopene has been associated with protection against several types of cancer (Morais, 2001), which accounts for the increasing interest in this carotenoid over recent years. Incorporation of this pigment in foods mainly aims at coloration and conferral of functional characteristics. However, due to its high number of conjugated double bonds, lycopene is susceptible to isomerization and oxidation during the storage process (Matioli and Rodriguez-amaya, 2002).

Microencapsulation can be an alternative to increase lycopene stability while enabling its dispersion in an aqueous medium. Microencapsulation has been used successfully in the food industry to protect substances that are sensitive to temperature, light, oxygen and humidity, to reduce the transfer rate from the core to the medium in which the product is located and to modify the physical characteristics of the material, facilitating handling (Desai and Park, 2005). The microcapsule consists of a layer of encapsulating material that acts like a protective film, isolating the active substance and avoiding the effects of its improper exposure (Jizomoto et al., 1993; Ré, 2006).

Lycopene encapsulation was already reported by various author the atomization method, using Gum arabic and maltodextrin (Matioli and Rodriguez-amaya, 2002), gelatin

and sucrose (Shu et al., 2006) and Gum arabic and sucrose (Nunes and Mercadante, 2007) as encapsulants.

The aim of this study was to develop micro capsules of lycopene by spray drying and use these capsules as a colorant in noodle.

2.0 MATERIALS AND METHODS

2.1 Raw materials

Fresh tomato processing industry waste of vijeta cultivar was collected from ANS Foods, Sagali, Maharashtra (India). Waste was dried in hot air oven at 50°C upto 10% moisture content. The dried wastage was ground in home grinder, packed in air tight HDPE bags, and stored in cold and dry condition until further use.

2.2 Extraction of lycopene

Estimation of lycopene was performed with slight modification in the quantitative assay for lycopene by reduced volumes of organic solvents suggested by Ranveer et al., 2013. In detail 250 mg sample was weighed and to it 3 mL of 0.05% (w/v) BHT in acetone, 3 mL of ethanol and 6 mL of hexane were added. The recipient was introduced in ice and stirred on a magnetic stirrer for 15 min. Then to it 3 mL of deionized water was added and shaken for 5 min. Sample were then left at room temperature for 5 min to allow the separation of phases. The supernatant (upper layer) was collected and one milliliter of that was diluted to 10 ml with hexane. The absorbance of the hexane layer was measured using a UV visible spectrophotometer (Shimadzu Co., Ltd., Japan) in a 1-cm-path-length quartz cuvette at 503 nm taking hexane as blank. The lycopene content was calculated by the following formula

$$\text{Lycopene } (\mu g/g) = \frac{A_{503} \times 31.2 \times \text{Dilution}}{\text{g of sample}}$$

2.3 Purification

Generally purification of the lycopene is carried out by chromatography, due to the high cost of stationary phase for chromatography; crystallization method was used for purification of lycopene (Nunes and Mercadante, 2004). The extract was dissolved in dichloromethane /ethanol (1:4) at temperature of 50 – 60°C, placed in ice bath for gradual lowered down the temperature and then placed in deep freezer for overnight to form crystals. The crystals were filtered through Whatman 4. filter paper, washed with cold ethanol and dried in freeze dryer (Cyber Lab,). The crystallization procedure was repeated to obtained crystals with higher level of purity.

2.4 Identification of lycopene by Thin-layer chromatography (TLC)

To confirm the purity of the precipitated lycopene, TLC was conducted according to the method of Britton (2008). Briefly, Silica Gel (0.25mm thick) was activated at 110 °C for 10 min was used for the TLC plates. The lycopene standard (Sigma L9879), crude lycopene and purified lycopen were developed with toluene-hexane (1:19, v/v) on the TLC plates.

3.0 MICROENCAPSULATION BY SPRAY DRYING

3.1 Preparation of emulsion

The emulsion of gum Arabic: sucrose was carried out by the procedure suggested by Zhu et al., 1998. The polysaccharide solution was prepared by dissolving 60g of gum Arebic and sucrose (7:3) in 200 ml water (45°C) by continuous starring for 30 min. The 15 mg of lycopene was dissolved in 20ml dichloromethane separately. The dichloromethane containing lycopene was mixed in polysaccharide solution by laboratory homogenizer at 7000 rpm for 30 min. In this emulsion 80 ml of distilled water was added to make 20% w/v soluble solids solution.

3.2 Encapsulation by spray drying

The microencapsulation was carried by spray drying method suggested Shu et al., 2006 with slight modification. In brief the above prepared emulsions were spray – dried on spray drier (LU-222, Labultima, Mumbai). The drying chamber with dimensions of 150 cm height and 80 cm diameter, a cyclone separator, plus hot air blower and a exhaust blower. The emulsion was fed at the speed of 2 ml /min into the drying chamber, entrance and exit air temperatures of 170 ± 2 and 113 ± 2°C, respectively, air pressure of 2 kgf/cm^2 from the blower in co-current flow mode and spray dried microcapsules were collected in the cyclone separator driven by exhaust blower.

3.3 Lycopene content of purified sample

Lycopene purity was determined using a spectrophotometery method similar to that reported by Schierle et al. (1997). Briefly, a certain weight of lycopene sample was dissolved in hexane and then diluted, which was assessed on a UV spectrophotometer (Shimadzu Co., Ltd., Japan) at λ max = 503 nm. Lycopene purity (or content) was calculated according to the following formula:

$$\omega = \frac{Ad}{Em}$$

Among which, ω —lycopene purity (or content), A— absorbance, d—dilution times, E = 3140, which is the extinction coefficient of lycopene at λ = 471 nm when n-hexane is used as solvent; m—weight of lycopene sample.

3.4 Lycopene incorporated Noodle

The control noodles were prepared as per the procedure discribed by Kulkarni *et al.,* 2012. The controlled noodle were made-up from refined wheat flour (100g) mixed with Iodized salt (2%), baking powder (0.5%) and water (35 ml).The sensorial quality characteristics like elasticity and texture were improved by addition of corn flour (10%), gluten (5%), GMS (1%) and guar gum (1%), whereas vegetable oil (10%) was added to improve the glossiness of the noodles. All these ingredients were mixed to form dough and extruded using single screw extruder. Obtained noodle strains were steamed and dried in a tray dryer at 60°C. The other two batches were prepared similarly as per the procedure stated above with addition of 1% free lycopene (Without encapsulation) and 1% encapsulated lycopene respectively.

3.5 Sensory evolution

All the noodle and milkshake samples were checked for market suitability by organoleptic test, which was conducted on 9

point hedonic scale. All the samples were judged for different sensory attributes like appearance, colour, taste, flavour and overall acceptability by a panel of semi-trained panel members (Ranganna 2000).

4.0 STASTICALANALYSIS

The analytical data obtained for experiments were subjected to analysis of variance (ANOVA) (one way anova) using complete randomized design according to Panse and Sukhatme (1961). The critical difference at $p<0.05$ was estimated and used to find significant difference if any.

4.1 Results And Discussion

4.1.1 Lycopene content of various sources

The proximate composition of peels showed that the Vijeta cultivar had higher values for lycopene and carotenoid content, so it was taken for further study. Different tomato fruit parts i.e. whole tomato, tomato pulp and peel, and industrial waste were screened for the lycopene content by solvent (tri-mixture) extraction method and obtained results are expressed in µg/g (table 1). The data revealed that higher value for lycopene content was found in peel (373.17±1.13 µg/g) followed by industrial waste (175.17±1.09 µg/g), whole tomato (80.90±0.79 µg/g) and tomato pulp (42.6±0.81 µg/g) on dry wet basis. This indicated that lycopene was accumulated in higher amount in peel than the other parts. Sharma and Le Maguer (1996) found that tomato extracts, especially skin extracts contain high amounts of lycopene. The tomato processing industry waste include seeds and skin residues which may leads to lower down lycopene content than the peel.

The results obtained for extraction of lycopene from tomato peel differ from those obtained using whole tomatoes, on account of the differences in the chemical composition of the peel and the whole fruit, as well as due to the fact that lycopene is reported to occur in higher concentrations in tomato peel. The peel of tomatoes has the highest total carotenoid concentration, and the locular contents have the highest carotene content. It has been reported that lycopene represents a substantial proportion of the total carotenoid content of tomato products (Choudhari and Ananthanarayan, 2007). It is estimated as much as 60–64% of the total carotenoid content consists of lycopene. Considering whole tomatoes, the peel content will be low (5.5–8.1%), which is the reason for lower lycopene content (Barrett *et al.*, 1998).

Lycopene was found predominantly in the chromoplast of plant tissues. In tomatoes, lycopene biosynthesis increases dramatically during the ripening process, as chloroplast undergoes transformation to chromoplast. Globulous chromoplast containing mainly b-carotene is found in the jelly part of the pericarp while chromoplast in the outer part of the pericarp contains voluminous sheets of lycopene (Choudhari and Ananthanarayan, 2007). Sharma and LeMaguer (1996) found that tomato extracts and especially skin extracts contain high amounts of lycopene.

The tomato processing industry waste comprises of skin and seeds (approximate in the ratio of 37:63), which lower lycopene content (Machmudah *et al.*, 2012) as seeds do not contain lycopene. However considering the cost of production of lycopene, it can be concluded that the waste of tomato processing industries, in the form of seeds and skin residues, could provide a useful source of lycopene (Sadler *et al.*, 1990).

Table 1.
Lycopene content of different sources of tomato

Sr. No.	Sample Name	Lycopene (µg/g)
1	Whole Tomato	80.90±0.79
2	Tomato Pulp	42.6±0.81
3	Peel	373.17±1.13
4	Industrial waste	175.17±1.09

Results are mean ± SD of 3 determinations

4.1.2 Identification of purified lycopene by Thin-layer chromatography (TLC)

To confirm the purity of lycopene, TLC was performed and chromatogram is presented in figure 1. The figure shows that crude extract sample gave 3 coloured spots i.e. red (Rf = 0.16), orange (Rf = 0.58), and yellow (Rf = 0.75), while purified lycopene sample gave a single red spot, which indicates that the extract is free from other carotenes. The Rf value of the red spot of purified sample was the same as that of lycopene standard. The orange and yellow spots of the crude extract represent γ-carotene and β- and ζ-carotene, respectively (Britton, 2008; Myong-Kyun *et al.*, 2013). This confirms that crystallization method used for purification of crude extract of lycopene sample was appropriate.

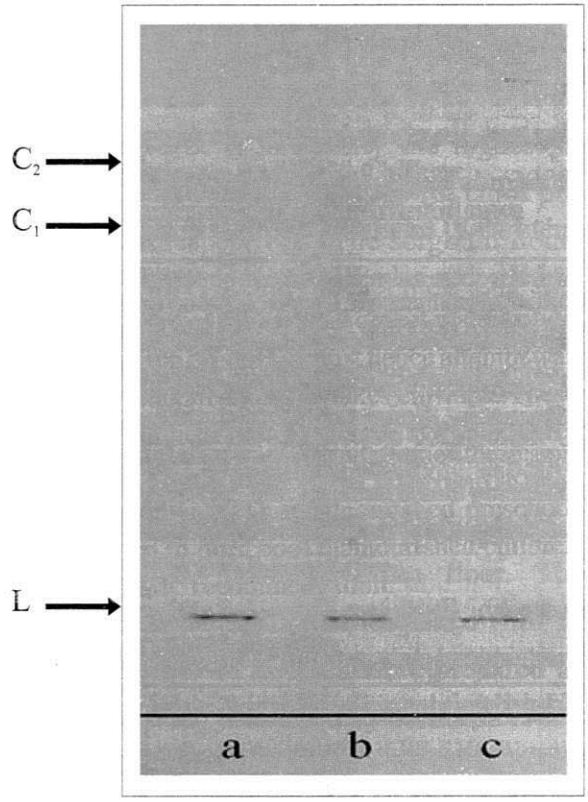


Figure 1. TLC of lycopene and carotenoids from (a) lycopene standard, (b) crude Extract, (c) purified lycopene. The arrows indicate L, lycopene; C_1, γ-carotene; C_2, β-carotene and ζ-carotene.

4.2 Structural analysis of encapsulated lycopene

The encapsulated samples prepared from sucrose : gum Arabic combinations of optimized process conditions i.e. core to wall ratio (1:4), sucrose to gum Arabic (7:3) and inlet temperature (180°C) were subjected to SEM analysis. Also the lycopene crystals without encapsulation were subjected to SEM analysis. Obtained SEM images are illustrated in figure 2. Micrographs of lycopene without encapsulation looked saw dust like surface, whereas microcapsules showed a spherical

shape appearance with 2–15 μm in diameter (mean diameter of 5 μm), smooth outer surface and a "bee net" like inner structure in of encapsulating materials (i.e. Sucrose – Gum Arabic combinations).

The formation of smooth outer surface were probably attributed to the addition of sucrose in the formulation, which could retain some water molecules linked to its own structure, filling the intern empty space of the microparticles, preserving the hydration, avoiding depressions on the surface, and thus assuring a more uniform and smooth wall of the obtained micro-particles. Bruschi et al. (2003) had reported that manniol to gelatin combinations as encapsulating material successfully resulted into a spherical and smooth-surfaced micro-particle of propolis. The reason for formation of "bee net"-like inner structure was unclear so far, but it seemed to be associated with the evaporation rate of water in core of micro capsules during micro encapsulation (Shu et al., 2006).

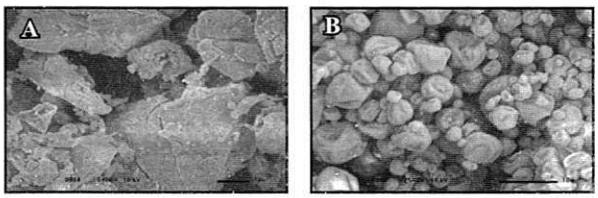


Figure 2. SEM image of (A) lycopene without encapsulation, (B) Lycopene encapsulated with sucrose and gum Arabic

4.3 Effect of lycopene incorporation on physicochemical properties of Noodles

The controlled noodle sample and sample added with free and encapsulated lycopene were subjected to physico-chemical analysis; obtained results are presented in table 2. The results of physico chemicals analysis showed that all noodle samples were good source of total carbohydrates and protein. The incorporation of lycopene in noodle samples did not showed any significant difference in protein, fat, ash and moisture content. Slight increased carbohydrate content was observed in the samples added with encapsulated lycopene i.e. NL_3 (76.10%), this was due to use of sucrose and gum Arabic as a carrier materials for encapsulation. Whereas carbohydrate content of control sample NL_1 (74.48%) and sample NL_2 (73.83%) added with lycopene without encapsulation was having little difference. The significant change in lycopene content was observed in the noodle samples. Only 0.012% lycopene content was recorded in the sample NL_2 which was supplemented with free lycopene (without encapsulation). Very good retention was observed in sample NL_3 (0.290%) supplemented with encapsulated lycopene. Even though noodle samples were added with 1% encapsulated lycopene; it contains only 30% of lycopene and 70% of carrier materials, which leads to lower lycopene content in the noodle sample. If the results of lycopene content of sample NL_2 and NL_4 were compared among each other, it showed that samples added with encapsulated lycopene (NL_3) had better retention than sample added with free lycopene. This also indicated that encapsulation gave better protection against heat processing.

Table 2. Physico-chemical compositions of noodle samples

Constituents	NL_1	NL_2	NL_3	SE	CD (p=0.05)
Moisture (%)	11.12	11.69	9.92	0.448	1.426
Ash(%)	0.895	0.890	0.846	0.015	0.046
Protein (%)	11.93	12.04	11.77	0.059	0.188
Fat (%)	1.58	1.55	1.46	0.026	0.083
Total Carbohydrate (%)	74.48	73.83	76.10	0.553	1.758
Crude fibre (%)	0.30	0.32	0.28	0.015	0.047
Lycopene (%)	---	0.612	0.290	0.081	0.258

Sample NL_1: control sample, Sample NL_2: sample added with free lycopene (Without encapsulation), Sample NL_3: Sample added with encapsulation lycopene (sucrose - gum Arabic)

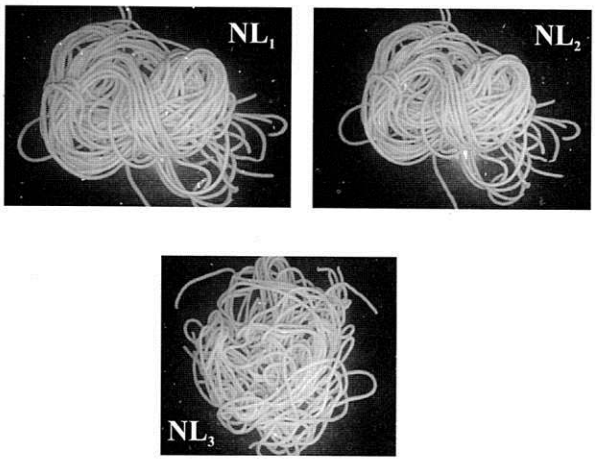
4.4 Effect of lycopene incorporation on sensorial properties of Noodles

All the noodle samples were subjected to sensory analysis to judge the market suitability of samples and obtained results are given in table 3. The photograph showing effect of lycopene addition is given in figure 4. All the samples showed at par results of sensory analysis with respect to flavor, taste, texture and overall acceptability, except for appearance. Samples NL_3 (8.5) which were prepared by incorporation of encapsulated lycopene had better sensory score for appearance than the control noodle sample (8.0). Even sample NL_2 (8.3) which was prepared by incorporation of lycopene without encapsulation had higher score for appearance than the control sample. This may be due to the likingness of the panel members towards slightly reddish appearance of lycopene added noodles.

Table 3. Effect of lycopene incorporation on sensory attributes of noodle samples

Samples	Appearance	Flavour	Taste	Texture	Overall Acceptability
NL_1	8.0	8.0	8.5	8.0	8.0
NL_2	8.3	8.0	8.5	8.2	8.0
NL_3	8.5	8.3	8.7	8.1	8.50
SE	0.118	0.075	0.058	0.048	0.144
CD (p=0.05)	0.376	0.238	0.184	0.152	0.459

Sample N_1: control sample, Sample N_2: sample added with free lycopene (Without encapsulation), Sample N_3: Sample added with encapsulation lycopene (sucrose - gum Arabic)



Sample NL_1: control sample, Sample NL_2: sample added with free lycopene (Without encapsulation), Sample NL_3: Sample added with encapsulation lycopene (sucrose - gum Arabic)

Figure 4. Effect of lycopene addition on appearance of noodle

5.0 CONCLUSION

The different parts of tomato showed peel (376.17±1.13) content highest amount of lycopene followed by industrial waste (176.17±1.09), whole tomato (83.90±0.79) and pulp (47.6±0.81). TLC analysis showed single spot characteristic spot of lycopene in purified sample. Degradation of lycopene was observed during processing when free lycopene was added in noodles. Results of these studies will helpful to small scale entrepreneurs and tomato processer to use their waste for extraction of value added pigment. This study also helps to improve storage stability of lycopene.

References :

Agarwal, S. and Rao, A.V. (2000). Tomato lycopene and its role in human health and chronic diseases. Can. Med. Assoc. J. 163 (6), 739–744.

Britton, G. (2008). TLC of carotenoids. In: Waksmundzka-Hajnos M., Sherma J. and Kowalska T. Eds. *Thin Layer Chromatography in Phytochemistry*, pp. 543-573, CRC Press, New York.

Bruschi, M. L., Cardoso, M. L. C., Lucchesi, M. B., and Gremiao, M. P. D. (2003). Gelatin microparticles containing propolis obtained by spray-drying technique: preparation and characterization. Int. J. Pharmacy 264: 45–55.

Choudhari, S. M. and Ananthanarayan, L. (2007). Enzyme aided extraction of lycopene from tomato tissues. Food Chem. 102: 77–81.

Desai, K.G.H. and Park, H.J., (2005). Recent developments in microencapsulation of food ingredients. Dry Technol. 23, 1361–1394.

Dimascio, P., Kaiser, S., Sies, H., (1989). Lycopene as the most effective biological carotenoid singlet oxygen quencher. Arch. Biochem. Biophys. 274, 532–538.

Schierle, J., Bretzel, W., Buhler, I., Faccin, N., Hess, D. and Steiner, K. (1997). Content and isomeric ratio of lycopene in food and human blood plasma. Food Chem. 59: 459–465.

Sharma, S. K. and Le Maguer, M. (1996). Lycopene in tomatoes and tomato pulp fractions. J. Food Sci. 2:107–113.

Shu, B., Wenli, Yu, Yaping, Zhao and Xiaoyong Liu (2006). Study on microencapsulation of lycopene by spray-drying. J. Food Eng. 76: 664–669.

Stahl, W. and Sies, H. (1996). Lycopene: a biologically important carotenoid for human? Arch. Biochem. Biophy. 336: 1–9.

Zhu, X., Xu, S.Y. and Wang, Z. (1998). Gelatin as microencapsulating agents for B-carotene Food and Fermentation Industries, 24 :11–15 (in Chinese).

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