DISTINCT FEATURES AND CHARACTERISTICS OF DHARWAD PEDA

THESIS SUBMITTED TO THE
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FOR THE AWARD OF THE DEGREE OF

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IN
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(DAIRY CHEMISTRY)

By

ANUJA C.VASU, B.Tech. (Dairy Technology)

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With a fresh look towards the harvest of prosperity and blessings ahead,
I seize each moment to reflect positively on my journey through
Traditional education to this summit.
Therefore, it is with immense thanks and invaluable appreciation
That I dedicate this work to the Lord,
Who by his abundant grace saw me through it all …
And to my loving family,
Whose spiritual and emotional acumen also thrusted a deeper sense
of inspiration, love and purpose in me.

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ANUJA C. VASU

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(Deemed University)

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IN

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Approved By

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This is to certify that the thesis entitled, "**DISTINCT FEATURES AND CHARACTERISTICS OF DHARWAD PEDA",** submitted by ANUJA C. VASU towards the partial fulfillment for the award of the degree of **MASTER OF SCIENCE** in **DAIRY CHEMISTRY** of the **NATIONAL DAIRY RESEARCH INSTITUTE (Deemed University)**, Karnal (Haryana), India, is a bonafide research work carried out by her under my guidance, and no part of the thesis has been submitted for any other degree or diploma.

6.6.2007

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company. Special thanks to Parvathy, Nitika, Jignesh, and Nutan who gave me all the support and help throughout my work.

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Date:6/06/07 *Anuja C. Vasu*

ABSTRACT

Dharwad Peda is claimed to be a distinct variety of peda produced with expertise developed in the Dharwad region of Karnataka. The uniqueness of the product was ascertained through comparison of its external features, rheological properties and chemical composition with those of other varieties of peda collected from the market. Unlike most other varieties which had a natural whitish yellow colour, traditional Dharwad Peda had typical natural brown colour with a coating of powdered sugar on its surface. It had distinguishing caramelized flavour associated with browning reactions and was more acidic than other varieties. Dharwad Peda had distinctly higher hardness, gumminess, springiness and chewiness than other varieties of peda. Cohesiveness too was found to be higher, but the difference was not statistically significant. The contents of major constituents of Dharwad Peda, in per cent, were: fat 14.21±1.40, protein 14.17±1.70, lactose 17.37±1.24, sucrose 38.97±3.60, ash 2.80±0.32 and moisture 13.33±1.30. Small, but statistically significant, differences were noticed in the composition of traditional Dharwad Peda from that of other varieties. Fat and protein contents were found to be less but the level of sucrose was more in Dharwad Peda compared to the samples of other varieties. Lactose, moisture and ash contents were similar. The composition of the samples of other varieties, in per cent, were: fat 16.74±2.80, protein 15.23±1.70, lactose 17.43±1.83, sucrose 34.38±6.42, ash 2.89±0.37 and moisture 13.63±1.66. Samples of peda produced outside Dharwad but sold as 'Dharwad Peda' had a composition similar to that of the products from Dharwad. They showed less uniformity in appearance and texture and, in general, scored lower in organoleptic evaluation.

सारांश

यह माना जाता है कि धारवाड़ पेड़ा एक अनोखी किस्म का पेड़ा है जिसे कर्नाटक के धारवाड़ क्षेत्र में विकसित विशिष्ट रीति से तैयार किया जाता है । इस उत्पाद के बाहरी रूप, बदलाव के लक्षण एवं रसायनिक रचना की निश्चितता बाज़ार से संग्रहित अन्य पेडों की तुलना से की गई । धारवाड़ पेड़ा प्राकृतिक भूरे रंग का होता है जिसकी सतह पर चीनी का पाउड़र चढ़ा होता है जबकि अधिकतर अन्य किस्म के पेड़ों का रंग पीलापन लिए सफेद रंग का होता है । अन्य किस्म के पेड़े से इस पेड़े में भुरेपन के प्रभाव के साथ विशिष्ट चासनी सुगन्ध युक्त एवं अम्ल युक्त होता है । अन्य किस्म के पेड़ों से धारवाड़ पेड़े में खास उच्च कड़ापन, लिसलिसाहटपन, लचीलापन एवं चबानेयोग्य होता है । इसमें संमिश्रण गुण भी उच्च पाया गया पर भिन्नता कोई विशेष गणन योग्य नहीं थी । धारवाड़ पेड़े की मुख्य पदार्थों की प्रतिशतता इस प्रकार है - वसा 14.21±1.40, प्रोभिजन 14.17±1.70, दुग्ध-शर्करा 17.37±1.24, चीनी 38.97±3.60, ऐश 2.80±0.32, आर्द्रता 13.33±1.30 । अन्य किस्म के पेड़े से धारवाड़ पेड़ा की रचना में कम परन्तु विशेष गणनशील भिन्नताएं पाई गई । अन्य किस्म के नमूनों की तुलना में धारवाड़ पेड़ा में वसा एवं प्रोभिजन की मात्रा कम पाई गई पर चीनी का स्तर अधिक पाया गया । दुग्ध-शर्करा आर्दता एवं ऐश की मात्रा समान थी । अन्य किस्म के पेड़ों की रचना की प्रतिशतता इस प्रकार थी वसा 16.74±2.80, प्रोभिजन 15.23±1.70, दुग्ध-शर्करा 17.43±1.83, चीनी 34.38±6.42, ऐश 2.89±0.37, आर्दता 13.63±1.66 । धारवाड़ से बाहर तैयार किए गए 'धारवाड़ पेड़ा' के नाम से बेचे गए नमूनों की रचना धारवाड़ में तैयार किए गए पेड़ों की रचना समान थी । इन्होनें दिखावट एवं बनावट की एकरूपता कम दिखाई, साधारणत: , तार्किक मुल्यांकन की गणना निम्न थी ।

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1.0 INTRODUCTION

The history of Indian milk products is as old as Indian civilization itself. Even as our ancestors began to domesticate milch animals, they found innovative ways to convert highly perishable milk into more stable and long lasting milk products. The nature of the product made, depended on the shelf life desired. The products like dahi were obtained by fermentation of milk and extended the shelf life, by a day or two. For intermediate shelf life, products like butter, khoa, chhana were made. In case longer shelf life was desired, products like ghee were manufactured. Most of these products acted as a base for production of popular milk sweets. These milk sweets became an inseparable part of social functions and festivals. Even today, a significant part of the milk produced in our country is being converted by the traditional sector into different milk sweets using simple age old practices such as acid coagulation, heat desiccation and fermentation.

Traditionally, a variety of milk sweets are produced in India, most of which are region specific. Eastern India, particularly West Bengal is the home of rasogolla and sandesh. Shrikhand is a popular dessert and forms a part of the meal on festive occasions in the states of Gujarat and Maharashtra. Kheer and payasam are delicacies popular in the northern and southern parts of India. Peda is popular all over India.

The production processes of the sweets as developed in the olden times were handed down from generation to generation to serve home and small trade. The *halwais* of different regions used their culinary skills to cater to the local tastes. Thus, within the basic process for their production, variations existed from one place to another that gave the products their distinct features. Many of these traditional products received little attention till late, as they were confined mostly to local markets. Dharwad Peda is one such product about which very little is known. The small scale of operation and non- organized retailing have resulted in a scarcity of information on its production and quality characteristics.

Usually, peda is prepared using khoa as the base material. Khoa is mixed with sugar in a pan and heated on a gentle fire till the mixture turns relatively firm. Then the pan is removed from the fire. If desired, nuts and flavourings are added. The contents are mixed thoroughly and made into balls or into different shapes using moulds. There are many varieties of this product in Indian market. Though the main steps involved in the production of these varieties are similar, the chemical composition of milk used, the quantity of sugar and flavourings incorporated, the heating parameters employed and the end point of production differ from one variety to another. These, in turn, affect their colour, flavour, body and texture and storage life.

Dharwad Peda is a distinct variety of peda. It is believed to be a variant of the earlier known Lucknow Peda with certain modifications brought out by the local sweetmeat makers of Dharwad district of Karnataka. While most other varieties of peda are whitish yellow, Dharwad Peda, typically, is dark brown in colour. Presence of higher levels of browning compounds which impart characteristic flavour and give longer shelf life to the product is claimed to be due to the uniqueness of the production process of Dharwad Peda. Another unique step in its production is the coating of powdered sugar on the surface at the stage when the thick mass is poured into small moulds and the product is allowed to solidify. It is this skilled colour and flavour development and the sugar coating which gives uniqueness to the product.

Products which are traditional and reputed to have characteristics essentially attributable to its geographical origin command premium price in commercial market. Therefore, such products are considered for the status of Intellectual Property. Certain geographical food names called Geographical Indications (GI) are protected in a way similar to Trademarks. A GI is used to identify agricultural, natural or manufactured goods produced or processed from a definite geographical territory having a special quality or reputation associated with the geographical environment. Geographical environment includes human factors such as special traditional knowledge of the producers established in the geographical area concerned. GI helps the producers to get a good brand value

for their product. Confectioners of Dharwad Peda have already taken steps to brand Dharwad Peda based on its geographical origin to create a niche for them in the market. For registration of the product under GI Act, it is necessary to establish the uniqueness of the product with respect to its features and chemical characteristics.

This work was undertaken in the above context. The objectives of the study were:

i) Documentation of the distinguishing features of Dharwad Peda.

ii) Assessment of the chemical composition of Dharwad Peda as compared to other varieties of peda available in the market.

2.0 REVIEW OF LITERATURE

The traditional milk sweets of our country are of wide range and have extra ordinary variety. Within the basic process for their production, variations exist from one place to another that give the products their distinctive features. The tiny scales of operation and non-organized retailing have resulted in a scarcity of data on the various parameters of production and quality of these traditional sweets. The available information on these products is presented below.

2.1 CLASSES OF TRADITIONAL MILK SWEETS

The traditional milk sweets can be classified based on either the intermediate base used for their preparation or on the broad production process employed.

2.1.1 Classification based on intermediate products

Sweets are manly prepared from three intermediate product bases: khoa, chhana and chakka.

2.1.1.1 Khoa based products

Khoa may be eaten as such, but it is by and large used as a base for a variety of sweets such as gulabjamun, sandesh, kalakand, ladoo and burfi. (Ray and De, 1952). Khoa is the intermediate base for peda.

2.1.1.2 Chhana based products

Chhana in an important indigenous milk product obtained through acid coagulation of milk and subsequent drainage of whey. Chhana is largely used as base for sweets such as rasagolla, sandesh, pantoa, kalojam, rasbundi etc. (Ray and De, 1953).

2.1.1.3 Chakka based products

Chakka is an indigenous milk product obtained after draining off the whey from dahi prepared by lactic fermentation of milk. It is commonly used in Gujarat and Maharashtra and even in South India. Shrikhand, a semisolid sweetish–sour fermented product, is obtained from chakka. Shrikhand is the first traditional milk product for which large scale production technology was worked out. Shrikhand wadi, a popular product, is an extension of shrikhand (Aneja *et al.*, 2002).

2.1.2 Classification based on production process

The traditional milk sweets can also be classified broadly into the following categories: Heat-acid coagulated, cultured/fermented, concentrated or desiccated.

2.1.2.1 Heat acid coagulated products

Paneer and Chhana are two important traditional coagulated milk products in this category.

Paneer, the indigenous variety of cheese, is obtained by the acid coagulation of heated milk (Sindhu *et al.*, 2000). It is primarily used for the preparation of culinary dishes such as Paneer Curry. Paneer is characterised by a typical mild acidic flavour with slightly sweet taste (Kanawjia and Singh, 2000).

Chhana is a soft, solid product formed by the acid precipitation of milk proteins (Aneja *et al.*, 2002). It differs from paneer as no pressure is applied to drain the whey and the pH is slightly higher (Sindhu *et al.*, 2000).

Rasogolla is one of the most popular chhana based sweet meats of Bengal, being made from cow milk curd which is kneaded into small balls that are boiled in clarified sugar syrup (Bhattacharya and Raj, 1980). Various types of rasogolla are sold in the market viz, “ordinary”, “sponge”, “canned”, and “diabetic”, which may be further classified as “small”, “normal” and “large” categories depending on the size of the balls. Each type of Rasogolla differs

from the other, with respect to taste, body and texture, method of preparation and packaging (Natarajan, 2002).

Sandesh is a popular chhana based sweet of Eastern India and Bangladesh. Sandesh can be broadly grouped into three main classes viz. soft grade (Naram pak), hard grade (Karapak) and Kachhagolla. The traders prefer to use cow milk chhana for sandesh preparation. Thoroughly developed chhana is admixed with sugar in a *karahi* by continuous stirring with the help of flat edged wooden ladle. Heating is continued at 75 to 85°C for 15 to 25 min depending upon the type of sandesh (Sen and Rajorhia, 1990).

Chhana Murki is another sweet prepared from a chhana base. It has the shape of small cubes, coated with sugar and has a firm body and close knit texture (De, 1980).

Cham-cham is a sweet prepared from chhana with a firm body and close knit texture. It is coated with sugar or khoa (Aneja *et al.*, 2002).

Chhana podo is a baked sweet, resembling milk cake. The production of Podo involves slow baking of chhana mixed with sugar and suji/maida (Ghosh *et al., 2002*).

2.1.2.2 Cultured/fermented products

The practice of preserving milk by fermentation is a common household technology in India. Fermented milks are mild to strong acidic in taste with pleasant aroma. Some products carry mixture of minor amount of alcohol, diacetyl and low melting volatile fatty acids imparting typical flavours. The main fermented milk products of India are dahi, makkan, lassi, butter milk, chhaka, misti dahi, shrikhand and related products.

Dahi is an indigenous dairy product obtained by lactic fermentation of milk. A good quality dahi is of firm and smooth consistency with sweet aroma and pleasant taste (Sindhu *et al.*, 2000). In India, dahi is largely made at home using traditional kitchen recipes, involving milk of buffaloes, cows and goats. For conversion into dahi, milk is boiled and allowed to cool under atmospheric conditions to room temperature. About 0.5 percent of ‘starter‘is stirred into the

cooled boiled milk, and then allowed to set undisturbed usually overnight (Srinivasan and Anantakrishnan, 1964). The composition of dahi is similar to the milk from which it is produced (Sindhu *et al.*, 2000). Dahi may be consumed as a sweet or savoury lassi drink or as a dessert containing sugar and fresh diced banana, orange slices, mango bits, and other seasonal foods. Dahi from buffalo milk is superior in body and texture than cow milk dahi. The composition of dahi is similar to the milk from which it is produced (Sindhu *et al.*, 2000). Homogenisation of milk improves the flavour intensity of dahi (Ghosh and Rajorhia, 1990).

Misti dahi (Payodhi, lal dahi) is a fermented milk product of West Bengal and other parts of Eastern India. It is prepared by heating buffalo milk with 12-13 percent cane sugar. The concentrated milk with a slightly caramelized flavour and brown colour is inoculated with a mixed starter culture consisting of *Streptococcus lactis* and *Streptococcus diacetylactis* strains. A firm curd with smooth body, sweet taste and pleasant flavour develops after about 7 hours of incubation at 30^0C.Misti dahi keeps well for 3-4 days at room temperature and for about 10 days in the refrigerator (Rajorhia, 2000).

Lassi is a refreshing beverage prepared by stirring up Dahi and adding sugar and small quantity of cold water. Lassi is a whitish, viscous, rich aroma and mild to highly acidic product (Aneja, 1992). Heating of lassi at 60^0C was found to increase its shelf life to 35 days compared to 21 days for control (Ramana, 1994).

Shrikhand is a very popular, highly viscous, very palatable fermented milk product of Western India. The average composition of shrikhand as per PFA is total solids (min.) 58%, milk fat (min.) 8.5%, milk protein (min.) .5%, titratable acidity (max.) 1.4% lactic acid, sucrose%(max.) 2.5%, total ash (max.) 0.9%. The traditional technology of shrikhand making involves: fermentation of milk with a mixed starter culture composed of *Streptococcus lactis* and *Streptococcus lactis* var *diacetylactis*, preparation of chhaka by draining of whey from curd and blending with additives like sugar, colour, flavouring and spices (Rajorhia, 2000).

2.1.2.3 Milk -based puddings/desserts

Cereal based milk products are popular all over India. Each region has its own distinctive products range in this category. Traditional Indian cookery includes several innovative blends of wheat and milk. Besides wheat, other cereals that are popular include millets, rice and sorghum, used in preparation of milk based cereal delicacies.

Payasam is a sweet delicacy of South India prepared especially on auspicious occasions. Payasam has many varieties with specialities and distinct characteristics attributed to the area specific traditional method of preparation. In general, preparation of payasam involves cooking of pulses (Bengal gram, Green gram), cereals or cereal products (rice, wheat, beaten rice, sooji, vermicelli, ada, sago), poppy seeds or fruit pulps (mango, banana, jack) in milk/coconut milk. Dry fruits and nuts are added to some varieties. In some cases, flavouring agents like cardamom, camphor or saffron are also added (Unnikrishnan *et al.*, 2000).

Kheer is a form of condensed milk prepared by concentrating whole milk to a ratio of 3:1 in open pans. The concentration is mostly done with the addition of sugar (5 to 8 % by volume of milk). Occasionally jaggery may be used in place of sugar. There is also the practice of cooking rice with sugared milk so as to maintain a final proportion of half and half of cooked rice and concentrated milk solids in the final product. The percentage composition of plain kheer is: water 45 to 55%, total solids 45 to 55%, fat 15 to 25%, lactose 14 to 16%, protein 12 to13%, ash 3.0 to 3.5% (Srinivasan and Anantakrishnan, 1964).

Phirni is a delicious variant of kheer. It is prepared by cooking milk with rice paste and sugar. Generally served in shikora (earthen cup), phirni is covered with a thin silver foil (Aneja *et al.*, 2002). Preparation of phirni involves boiling standardized milk in a stainless steel container vigorously for 2-5 minutes with constant stirring and scrapping. The calculated amount (@100g/kg) of cleaned and washed rice in the form of slurry is added into the boiling milk with constant stirring till it become a little thick. When the desired consistency is reached, calculated amount of sugar is added slowly with stirring into the hot product. The

product is cooled to room temperature and filled in aseptically cleaned glass containers and is stored at refrigerated temperature (Mathur *et al.*, 1985).

Gajar-ka-halwa is bright reddish brown with certain darkened but glossy fragments of grated carrot. Its texture is crumbly but with a typical mellowness. The characteristic aroma of Gajar-ka-halwa is a blend of cooked carrots, heat-concentrated milk and caramelized sugar (Aneja *et al.*, 2002).

Kaju burfi is one of the most popular among Indian sweets because of its delicate texture, good flavour and excellent mouth feel. Kaju burfi is a delicacy containing cashew nut, sugar, milk solids and at times certain minor ingredients like jaggery and cardamom (Satyanarayana *et al.*, 1993).

2.1.2.4 Desiccated milk based products

An impressive array of heat desiccated milk products is available. Khoa, an intermediate concentrate, is the base for a wide range of sweets such as peda, gulabjamun, burfi, kalakand, rabri, kulfi and their variants. The heat processing and accompanying reduction in water activity result in a substantial destruction of pathogenic and spoilage micro organisms as well as inactivation of enzymes. Besides, desirable heat induced chemical interactions among milk constituents result in lowering of redox potential and water activity, there by extending the product shelf-life under the ambient temperatures of tropical climate.

Rabri, a partially concentrated and sweetened whole milk product containing several layers of malai, is an important item of Indian food particularly of Northern and Eastern regions from ancient time. Rabri is creamy white to caramel in colour, possesses viscous body containing several layers of clotted cream with a chewy texture. It has a pleasant caramelized flavour. The chemical composition of the product depends on the initial composition and quality of the milk and the degree of concentration of the milk solids and the quality of milk added (Aneja *et al.*, 2002). Buffalo milk is normally used for preparing rabri, owing to its high total solids and superior taste in the final product. The method involves standardization of buffalo milk to 6% fat, its simmering in a steam

part of the kettle or to a separate container, concentration of milk to three-fold after removing about 100g clotted cream from 1 kg milk and adding sugar @ 6% of initial milk to the concentrated milk. The clotted cream is finally added to the concentrated sweetened milk (Gayen and Pal, 1991a). Wide variations in the market samples of rabri have been reported (Gayen and pal, 1991 a). The approximate composition is as follows: moisture 30%, fat 20%, protein 10 %, sugar 20 %, lactose 17%, ash 3% (Aneja *et al.*, 2002). Rabri has very limited shelf life. When packaged in polystyrene ups, it has a shelf life of about 18 hours at 30 ^{0}C and 20 days at 5^{0}C (Gayen and Pal, 1991b).

Basundi is a heat desiccated, thickened milk dessert, having white to light caramel colour, creamy consistency with soft textured flakes that are uniformly suspended throughout the product matrix. Basundi has a sweetish caramel aroma. Generally whole buffalo milk is preferred for the preparation. The milk is kept on open fire in shallow pan of a vessel. Evaporation is continued till concentration is achieved to about two fold by slow boiling with continuous agitation and scrapping to avoid burning. If the film of milk constituents is formed on the milk-air interface, it is stirred back into milk. It gives typical soft-textured flakes, which remains uniformly suspended in thickened milk. After reaching to the desired concentration, cardamom or nut mug powder and dry fruits are added. The product is then cooled and served as a special and delicious sweet dish. It can be consumed as such like kheer or along with specially prepared four-folded chapatti (Pagote, 2003). Pagote (2004) has reported average composition of basundi: fat 12 to 13 %, MSNF 17 to 19%, sugar 13 to 14%, TS 43 to 46%. The shelf life of basundi is very limited. If basundi is heat treated at 5 psi for ten minutes after proper packaging, it would remain acceptable up to 5 - 7 days at 37 ^{0}C and 22 to 25 days at 7^{0}C (Pagote, 2005).

Khurchan is an indigenous concentrated milk product quite popular in Northern India. Traditionally, khurchan is prepared from buffalo milk. It has white to light cream colour. Typically body of khurchan consists of firm layers of milk solids. It has rich, smooth but somewhat chewy texture. This product has distinctive pleasant caramel/cooked flavour. Heat clotted fraction of milk absorbs

unclotted milk in the milk liquid phase, which imparts softness to the product (Aneja *et al.*, 2002). Khurchan is normally prepared by heating 3 to 4 kg milk in a *karahi* to simmering temperature (85 to 90^0C) and then carefully maintaining it at this temperature by controlled heating. In no case is the milk allowed to boil; nor is it stirred (until sugar is admixed). This helps in the formation of a thick creamy layer on the upper surface of the milk. When the volume of the milk gets reduced by the evaporation of water to one fourth to one sixth of the original, good quality ground sugar is added to the concentrated mass at 5 to 6 percent by weight of the original milk and dissolved in it. The finished product has slight cooked flavour, which is relished (De, 1980). The proximate composition of Khurchan is as follows: moisture 22.8 to 27.2%, fat 22.6 to 22.4%, protein 14.6 to 16.2%, lactose 14.1 to 15.3%, sucrose 18.1 to 18.5%, ash 3.0 to 3.2%, total solids 72.8 to 77.2% (Aneja *et al.*, 2002).

Dhap khoa having 40-45% moisture is normally used for the preparation of gulabjamun. It is shaped both round and cylindrical having golden to dark brown colour and has a soft to firm body and smooth texture. It is soaked in thick sugar syrup. Variation includes pantoa and lalmohan, both Bengali treats with mixture of chhana and khoa. (Aneja *et al.*, 2002). The composition of Gulabjamun, on the drained weight basis, varies in the following range: moisture 2.5 to 3.5%, fat 2.5 to 10.5%, protein 6 to7.6%, ash 0.9 to 1 %, total carbohydrates 43.0 to 48.0 % (Pal, 2000).

The method of making gulabjamun from Dhap khoa has been standardized (Ghosh *et al.*, 1986). A mechanized semi-continuous system is adopted for the manufacture of gulabjamun from khoa at Sugam Dairy, Baroda. The shelf-life of gulabjamun at ambient temperature, in sugar syrup, is 5-7 days which can be extended to 3 weeks by hot filling in polystyrene cups and adding 0.1% potassium sorbate as a preservative (Pal, 2000). The shelf life of canned gulabjamun is about six months at room temperature (Aneja *et al.*, 2002).

Ghosh *et al.* (1986) have developed the formulation of gulabjamun mix powder from both roller as well as spray dried skim milk. The shelf life of these mixes in metalized laminate pouches are about 9 months at room temperature.

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Burfi is another khoa based sweet popular all over India. Several varieties of burfi are sold in the market depending on the additives present, viz. plain mawa, pista, nut, chocolate, coconut and rava burfi. Good quality burfi is characterized by moderately sweet taste, softened slightly greasy body and smooth texture with very fine grains. Colour, unless it is chocolate burfi, should be white or slightly yellowish. The method of manufacture of burfi has been standardized for small as well as large scale (Reddy, 1985; and Palit, 1998). Storage at 5-7°C is recommended for prolonging the shelf life of burfi.

2.2 KHOA

Khoa is an important indigenous whole milk product obtained through partial dehydration of milk by direct evaporation over open fire. It constitutes one of the chief bases for making Indian milk sweets. It has been defined under PFA as the product obtained by rapid drying of milk of cow or buffalo or goat or sheep or a combination of thereof. The milk fat shall not be less than 20 percent of the finished product. Khoa may contain citric acid not more than 0.1 percent by weight.

For commercial trade, three main types of khoa are recognized – Dhap, Pindi and Danedar, each type having preferred end uses. Types of khoa and their preferred uses are given below:

Type of khoa	TS %	Fat %	End uses
Dhap	56-63	20-23	Gulabjamun
Pindi	67-69	21-26	Burfi, Peda
Danedar	60-65	20-25	Kalakand, Milk cake

The Bureau of Indian standards specifications for the three types of khoa are as under:

Khoa type	TS (Minimum)	Fat in dry matter (Minimum)	Ash in dry matter (Maximum)	Titratable acidity as % lactic acidity (Maximum)
Dhap	55	37	6	0.6
Pindi	65	37	6	0.8
Danedar	60	37	6	0.9

2.2.1 Technology

The following procedure is adopted for the preparation of khoa: Milk (4-6 litres) is poured into a *karahi* brought to boil by placing over a *chulah* of brisk non-smoky fire. As soon as the milk starts boiling, it is stirred continuously by turning with an iron-stirrer called *khunti*. After about 10 to 12 minutes of rapid evaporation when concentration of about 2.5 to 3 times has been attained, coagulated particles are brought together with the stirrer and compacted as a semisolid mass. As heating continues further with constant agitation and scraping of the heating surface, free fat oozes out. From this stage subsequent heating has a pronounced effect on the development of typical khoa flavour and texture. Since colour tends to change rapidly at this stage, heating is slowed down. Gradually the solid mass tends to leave the heating surface cleanly, and a pat is formed. The end product is then removed from the pan, spread uniformly over trays and allowed to cool under atmospheric conditions. (Ray and De, 1952).

The first attempt to develop semi-continuous khoa-making machine was made by Banerjee *et al.* (1968) which was followed by batch type mechanical conical process vat developed by Agrawala (1987); batch type semi-mechanized scraped surface heat exchanger developed by More (1990) and scraped surface

continuous khoa making machines developed by NDDB (Punjarath *et al.*, 1990, Dodeja *et al.,* 1992 and Christie and Shah, 1992). The Contherm-Covarp scraped surface heat exchanger system developed by ALFA-LAVAL is also being commercially used for the manufacture of khoa (Patil, 2002).

Pal and Cheryan (1987) developed a process for the manufacture of khoa using reverse osmosis. Dewani and Jayaprakasha (2002b) found that preconcentration of milk by membrane processing technology and vacuum evaporation could be effectively utilized for the preparation of khoa.

2.2.2 Quality profile

For the preparation of quality khoa the minimum fat content should be between 4.5 and 5.0% with a ratio of solids-not-fat/fat ratio of 1.7 to 1.9 (Ray and De, 1952). Khoa made from cow milk was pale-yellow in colour whereas that from buffalo milk was light greenish-white. Cow milk khoa is just suitable for the preparation of sweets. This is because the khoa has a sticky body and stickiness hampers the proper incorporation of sugar in the sweet. Similarly, the sandy texture did not permit the proper admixture with the flour at the time of sweet making. The khoa made from buffalo milk has a soft loose body and smooth granular texture and is highly suitable for making sweets because of its easy permeability by the sugar syrup and proper admixture with added flour (Ray and De, 1952). Homogenized milk khoa is softer and lighter brown in colour and could not be patted together like the unhomogenized milk khoa, and the fat leakage was lower (2-6% Vs. 17-32%). Peda prepared from unhomogenized milk khoa was softer, thicker and more acceptable than that made from unhomogenized milk khoa (Mulay and Ladkani, 1973).

The physical quality of khoa made in the continuous khoa making plant under optimum conditions of production was on the whole similar to that made by the batch *karahi* method for both types of milk. Whereas the body was softer, due to higher moisture content, the texture was not so smooth probably because the extend of stirring was considerably less than what is possible in the *karahi*

method (De and Singh, 1970). Dodeja *et al*. (1992) *could* produce khoa with smooth body and uniform grains which was suitable for making sweets.

Khoa has a low keeping quality. Keeping quality is more related to yeast and mold counts than bacterial counts (Deshmukh *et al.,* 1997). By itself it keeps well for 4-5 days in cold weather and for 2-3 days in hot weather (Rangappa and Achaya, 1948). Sharma *et al.* (1972) suggested that for a satisfactory grade khoa the SPC, coliform and enterococcus counts should not exceed 10million, 5,000 and 10,000/g respectively*)*. Ghodeker *et al.* (1980) studied the microbiological quality of khoa collected from halwai shops. The application of microwave heating was observed to be quite superior in reducing SPC, yeast and mold count and spore count and also showed very slow rate of increase during a preservation period of 7 days (Chavan and Kulkarni, 2006).

Keeping quality of khoa increased with increase in total solids content. The shelf life of khoa containing 70, 80 and 90% TS was respectively 4, 6 and 9 days at 30^0C, 7, 8 and 15 days at 22^0C and 35, 45 and 50 days at 5^0C.There was no significant effect of TS on bacterial count (Deshmukh *et al.*, 1997). The addition of sugar prolonged its life to 3–4 months (Rangappa and Achaya, 1948). Rudreshappa and De (1970) observed a normal storage life of khoa at 37 ± 1^0C to be less than 7 days, which could be increased to 14-21 days by packaging at 80-90^0C.

The keeping quality of khoa was low during summer (Thompkinson and De, 1981). Drying of khoa is expected to substantially extend storage life. The average storage life of dried khoa, was 90 days when air packed and stored at room temperature (16- 30^0C), and 105 and 60 days respectively when gas-packed and stored at room temperature and 37 ± 1^0C (Patel and De, 1977). Thompkinson and De (1981) found a shelf-life of 60 days and 45 days respectively for cow and buffalo milk khoa powders when stored at 37 ± 1^0C. With sufficient care in preservation, it is easy to keep khoa for long periods. Addition of natamycin (0.5%) and potassium sorbate (0.3%) as antifungal agents, showed lower yeast and mold count during storage at 30^0C and 5^0C respectively (Rajarajan *et al*., 2006). A combination of low initial moisture level (20-25%) and

high packaging temperature (80-90^{0}C) ensured a maximum storage life of 14-21 days in the unsterilized cans (Rudreshappa and De, 1970).

Aseptic packaging of khoa in radiation sterilized laminated pouches extended the shelf-life to 7-22 days as against 1-3 days for unpacked samples when stored at 37^{0}C.The shelf life of the product remained unaffected by vacuum packaging (Sharma *et al.*, 1978). Khoa samples packed in parchment paper and polyethylene remained acceptable up to 5 days at 37^{0}C and up to 14 days at 8$\pm$1^{0}C. Four ply aluminium laminates proved to be the best for packaging of khoa followed by two-ply packs, high-density polyethylene and parchment (Kumar *et al.*, 1975). When 40% formalin applied at a rate of 0.1ml/25g the samples could be stored for>10 months (Mukherjee and Mathew, 1974). Addition of 0.2-0.4% potassium sorbate increased the shelf life from 2 days at 30^{0}C and 20 days at 5^{0}C to 10-11 days at 30^{0}C and $\leq$ 40 days at 5^{0}C(Jha *et al.*, 1977). Addition of nisin (100 Reading units/g) to canned khoa increased the shelf life by 1 month, 2 weeks and 3 weeks at 10, 20 and 30^{0}C respectively. Nisin was very effective in checking the growth of yeast and mold (Karla *et al.*, 1973). Rajorhia (1983) found that addition of nisin (10^6 Ru/g) and potassium sorbate (0.4%) could keep khoa well for 20 days at 30^{0}C.

Patel and De (1977) made an attempt to standardize the method of production of khoa powder. Drum-dried khoa had a brownish white colour, fairly uniform texture, definite cooked smell, slight sweet taste and was suitable for making peda where as that from spray-dried khoa had a chalky white colour, lumpy texture, slight cooked smell and slight sweet taste and was unsuitable for making peda. Thompkinson and De (1981) found that acceptable quality peda could be made using buffalo khoa powder whereas that from cow khoa powder was chalky and sticky.

Naidu and Ranganathan (1965) found mold growth on the surface after a storage period of 72 hours at 30$\pm$1^{0}C. Pronounced discolourations as well as disagreeable flavours were noticed after a storage period of 144 hours at the same temperature. The defects commonly encountered in khoa are flavour (smoky, acid, rancid, stale), body and texture (hard, coarse, gritty), colour and

appearance (dry surface, burnt particles, mouldy surface, fat and/ water leakage)(Aneja *et al.*, 2002).

2.3 PEDA

Peda is a popular khoa based, indigenous and heat desiccated milk product, which is prepared from cow milk, buffalo milk or a combination thereof. It has been reported that the quantity of peda produced in India exceeds any other indigenous milk based sweet, using khoa as base material (Mahadevan, 1991). The manufacture of peda is mostly restricted to '*hallwais*'. Peda is whitish yellow in colour, and has a coarse grainy texture. Since peda has lower moisture content it has a better shelf life than many other milk sweets. The preparation of peda is at present limited to the use of khoa as a base material.

2.3.1 Technology

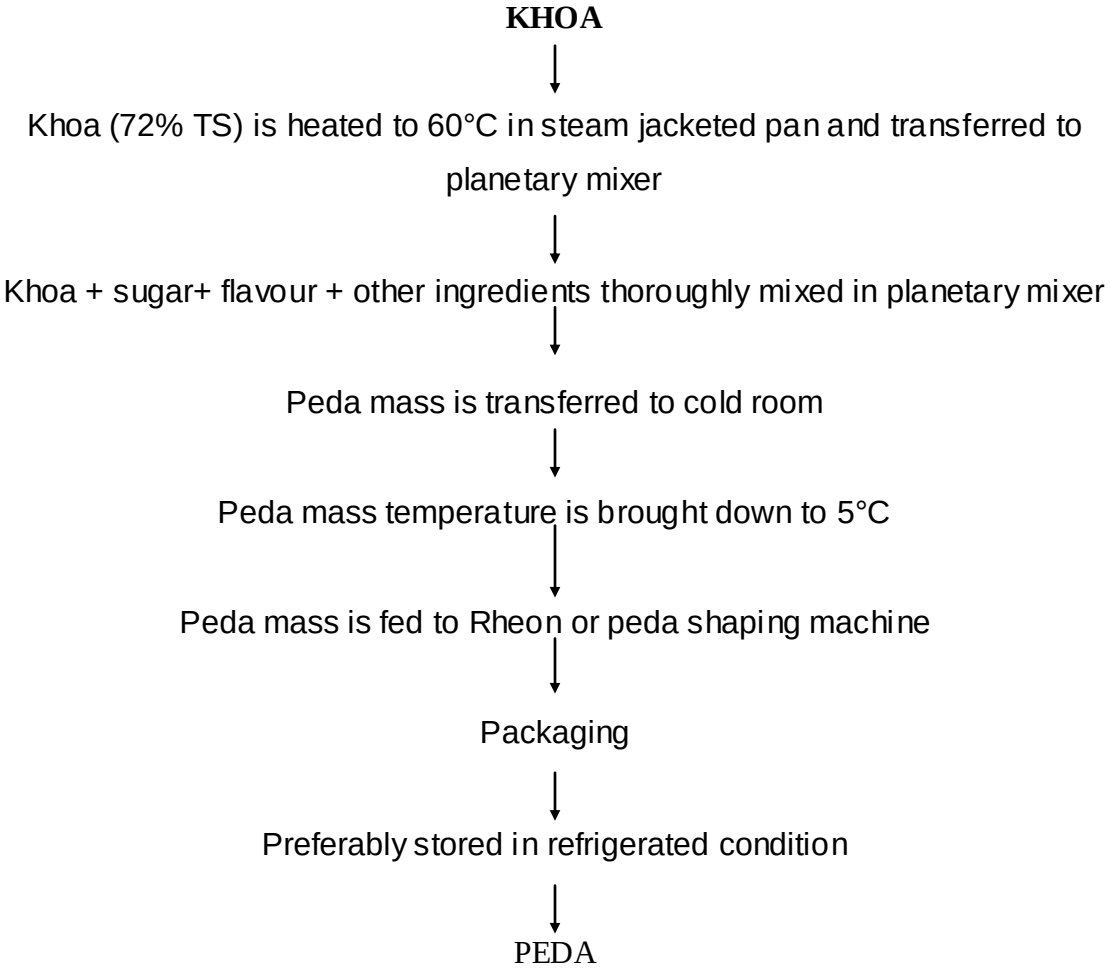
Khoa is mixed with sugar and then heated in a vessel. After heating, desired flavouring and nuts are added to the mass, at times. The process removes some of the moisture of khoa, and improves the shelf life of the product. Further, sugar exerts a preservative effect and provides sweetness. Numerous varieties of peda are manufactured, the methods of which may vary from region to region depending on the consumer's requirement. Regional preferences for quality determine the method of preparation, as a result of which sensory and chemical attributes vary considerably. Some prefer white colour of peda and other may ask for yellowish colour.

According to Patel and Gandhi (1980), 600 l of buffalo milk can be converted into 168 kg peda in an eight hr. shift by deploying a set of six crude oil combustion furnaces. About 5l of milk is taken in one batch. As soon as milk comes to first boil, about 450 g of sugar is added and the stirring and scraping continued until a pasty consistency is obtained. The paste is spread out on the walls of the pan for cooling. The product is removed to a tray and moulded into desired shapes. The final product contains about 13-13.5% moisture. Similar approach in peda making was adopted at the rural milk processing centers at

Kutch district run by the Gujarat State Rural Development Corporation. Six litres of milk was heated in as open pan iron vessel in a diesel furnace and 400 g of sugar added at the last stage of khoa making. The product was cooled and shaped in circular balls of about 25 g each, measuring 4-cm. diameters and 1.5cm height (Reddy and Rajorhia, 1992). The product may also be formed into different shapes, using disc or moulds. Cardamom is commonly added for flavouring the peda. Some manufacturers also use permitted colour to prepare pedas of different colours. Incorporating 1-2 percent cocoa makes chocolate pedas. For Kesar or Saffron peda, a preferred variety, saffron is mixed for added flavour and colour.

Recently, some plants have undertaken peda production using mechanized equipment and Rheon extruder. They use a planetary mixer for effecting uniformity from batch to batch. The R & D group of NDDB, Anand, has recently developed a peda-moulding machine and a continuous peda line. A flow diagram for the conversion of khoa into peda is shown below. Khoa is concentrated to 72 percent total solids and heated to 60°C in a steam-jacketed pan. After transferring khoa to a planetary mixing vessel, sugar and flavourings are added and mixed thoroughly. The peda mass is then stored at 0-4°C for about 10 hours to bring the temperature down to 4-5°C and then fed into the peda shaping machine. The pedas are shaped, packaged and then stored under refrigeration (Aneja *et al.*, 2002).

A flow chart for the conversion of khoa into peda is given below



In Mathura district of UP, khoa is first cooked to brown colour in ghee and then peda is prepared by blending sugar and other additives (Pal, 2000).

2.3.2 Quality profile

Limited information is available on the quality of peda collected from different parts of the country. The quality of khoa, quantity of sugar added the extent to which the mixture is heated and the storage conditions would influence the composition of peda (Reddy and Rajorhia, 1992). No attempt has so far been made to formulate the quality standards for this sweet.

2.3.2.1 Chemical composition

Sharma and Zariwala (1978) studied the chemical quality of peda marketed in Bombay. Wide variations have been reported in the chemical constituents: moisture 4.2 to 14.2%, fat 7 to 25%, acidity 0.8 to0.41%, protein 1.4 to 12.1, lactose 4.0 to 18.6%, sucrose 13.2 to 41.3%.

A study was conducted by Sharma and Upadhyay (1997) to characterize peda manufactured by traditional technology in Maharashtra and Gujarat. They have reported the following average composition: moisture 14.36%, fat 19.31%, protein 15.34%, lactose 15.25%, ash 2.47%, sucrose 33.27% whereas the same for peda manufactured by mechanized process was moisture 15.84%, fat 15.25%, protein 15.27%, lactose 16.43%, ash 2.81%, sucrose 34.40%. Peda manufactured by traditional technology was distinctly superior in its sensory attributes compared to mechanized processed product.

Ray *et al.* (2002) compared the quality of peda available in the market of Kolkata and that made in the laboratory. Simultaneously peda was also prepared in the laboratory from cow as well as buffalo milk. The average fat content of market peda was 14.1 $\pm$ 1.90%. The fat contents of laboratory made cow and buffalo milk peda were 22.83 $\pm$ 0.85% and 31.74 $\pm$ 0.93% respectively. Market peda sample showed higher titrable acidity, free fatty acids, sucrose, peroxide value, and low protein, lactose and ash content, as compared to laboratory made cow and buffalo milk peda. Out of thirty-five samples collected from Kolkata market, fourteen showed the presence of neutralizer (alkali), seven showed the presence of starch.

Dewani and Jayaprakasha (2002a) studied the effect of addition of whey protein concentrate on the physico-chemical and sensory characteristics of peda. It was found that with the increase in the level of whey protein concentrate in the admixture, yield, acidity, hydroxy methyl furfural and penetration values increased correspondingly whereas fat, lactose and ash content decreased proportionately as a result of the increase in the moisture content.

Patel *et al.* (2006) compared the quality of peda prepared by traditional methods(TM) by traders and those manufactured by mechanized method (MM)

by a commercial dairy. The peda manufactured using TM from different traders were superior in chemical and sensory quality than those manufactured using MM.

2.3.2.2 Microbiological quality

Because of its intermediate moisture range and non-acidic nature (Thakur *et al.,* 1992), spoilage in peda is most commonly by growth of yeasts and molds (Sharma *et al.*, 2003). Many workers have reported the presence of significantly high microbial counts and certain pathogenic bacteria in peda (Kudchodkar and Singh, 1964; Garg and Mandohkhot, 1984; Mandokhot and Chandiramani, 1988).

Kudchodkar and Singh(1964) isolated enterotoxigenic staphylococci from market samples of peda. Peda samples drawn from Allahabad city carried a standard plate count of 45 x 10^5/g (Singh *et al.*, 1975b). Similarly, 70 samples of peda collected from Agra city by Singh *et al.* (1975a) were found to have high total bacterial count, spore forming bacteria and molds.

The stored samples of peda collected from Mysore market were also found to carry coagulase positive Staphylococci and Salmonella (Dwarkanath and Srikanta, 1977). Garg and Mandokhot (1984) could isolate *Escherichia coli*, *faecal streptococci*, *Corynebacterium* and *Staphylococci* and *Bacillus* from peda samples. The SPC of peda ranged between 1.18 x 10^3 to 5.68 x 10^5/g.

In a study conducted by Kakar and Udipi (1997) pathogenic microorganisms like *Staphylococus aureus* and *Salmonella enteritidis* were observed in samples of peda.

Ray *et al.* (2002) found a high yeast and mold and coliform content in market peda samples as compared to laboratory made peda. Patel *et al.* (2006) found that the peda manufactured by MM were superior in microbiological quality as compared to that made by traditional method.

2.3.3 Shelf life

The shelf life of peda under normal packaging condition at room temperature is about 2 weeks. It can be increased to about 40 days by packaging

in pre-sterilized shrink-wrap. Replacement of 50% cane sugar with corn syrup reduced the water activity to about 0.6 and enhanced the shelf life up to 45 days in addition to improving the body and texture. Addition of 0.1% sorbic acid at the end of manufacturing process was found to extend the shelf life of peda up to 45 days of 30°C. Packaging of peda samples in multilayer transparent laminates with oxygen scavenger extended the shelf life up to 2 months at 37°C, 5 months at ambient temperature and 6 months at 20°C (Kumar *et al.*, 1997). Bandekar *et al.* (1998) found that treatment of peda with 3KGY dose of γ-radiation at 0^0C could improve its microbial safety. Packaging of malai peda under vacuum nitrogen and storage at refrigeration were found to keep it acceptable even after 31 days (Sharma *et al.*, 2003).

2.4 DHARWAD PEDA

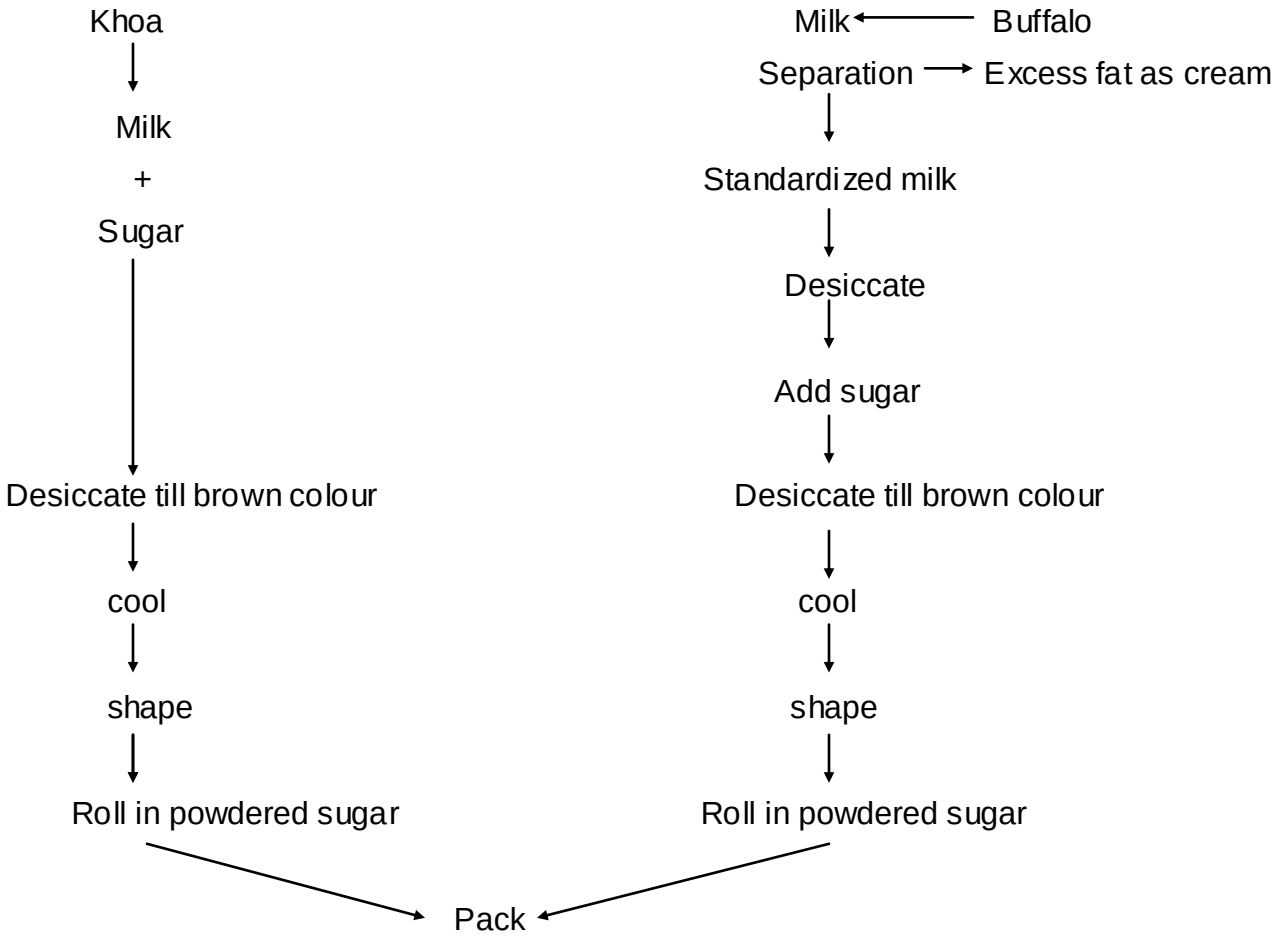
Dharwad Peda originates from Hubli-Dharwad district and surrounding areas in the radius of about 50km from the twin cities of Hubli-Dharwad in Karnataka state. Believed to be introduced by Sri Mohan Singh, a Thakur, about two centuries ago, it is a variant of the earlier known Lucknow Peda with certain local adaptations. The annual production of Dharwad Peda during 2003-04 was about 91 tonnes (Dixit *et al.*, 2003). It is customary in this area to announce any good news to friends and relatives with a pack of Dharwad Peda. It is produced on small scale by local sweet meat makers in the non-organized sector. A small portion of the product is exported (Kulkarni and Unnikrishnan, 2006).

2.4.1 Technology

Dharwad Peda is traditionally prepared from fresh buffalo milk. In the initial years only milk was used as a raw material for production. In the traditional method of production, the milk is first boiled in a large round pan to make khoa. It is then desiccated along with sugar with continuous heating and stirring. The desiccation process requires skill and experience to avoid overheating which would result in charring but at the same time provide uniform heat to produce the

caramelisation and Maillard reaction. Another unique step in the production is the coating of powdered sugar on the surface at the stage when the thick paste is poured into small moulds and product is allowed to solidify. It is this skillful colour and flavour development and the sugar coating, which gives uniqueness to the product (Kulkarni and Unnikrishnan, 2006).

A general Flow diagram for the manufacture of Dharwad Peda is given below



2.4.2 Characteristics

Typically Dharwad Peda is dark brown in colour. The desired level of browning which imparts characteristic flavour, texture and longer shelf life to the product is the uniqueness of the product. It has a soft but firm, cohesive body and granular texture. It stands up well in rounded shapes (Aneja *et al.*, 2002).

The product is observed to have low water activity due to which its shelf-life is about 7 to 10 days at ambient temperature and about a month at refrigerated temperature (Kulkarni and Unnikrishnan,2006).

2.4.3 Chemical Composition

Detailed characterization of the product has not been done yet (Aneja *et al*, 2002). The proximate composition of the product is reported to be as follows: fat 18 to 21%, protein 14 to 16%, lactose 14 to 16%, sucrose 37 to 39%, moisture 12 to 14%, ash 3 to 4% (Kulkarni and Unnikrishnan, 2006).

Confectioners of Dharwad have already taken steps to brand this sweet based on its geographical origin to create a niche for them in the market. The unique features and characteristics of the product, related to the area are of important consideration while granting registration to the product under GI Act. The uniqueness of the product is yet to be established.

3.0 MATERIALS AND METHODS

This chapter deals with the various materials used and methods employed during the investigation relating to analysis of peda.

3.1 COLLECTION OF PEDA SAMPLES

Different brands of Dharwad Peda produced in Dharwad, samples of peda sold as 'Dharwad Peda' but produced elsewhere and also other varieties of peda were collected from the market to differentiate Dharwad Peda from these varieties. In all cases, two samples of the same brand were procured on different dates, for analysis.

3.2 REAGENTS

All the chemicals utilised for the preparation of different reagents were of "Analytical Grade" (AR).

3.3 INSTRUMENTS

3.3.1 pH meter

pH meter (Cyberscan 2500, Eutech Instruments) was used. The electrode assembly was calibrated against standard buffer of pH 9.2 and 4.0.

3.3.2 Kjel Plus Digestion and Distillation Assembly

Kjeldahl digestion unit and KjelPlus distillation unit of Pelican Instruments, Chennai, were used to estimate protein content.

3.3.3 Texture Analyser

TA-XT plus, Stable Micro System, England was used for measuring the rheological properties of peda.

3.3.4 Spectrophotometer

Elico, scanning minispec, SL-177, INDIA was used for absorbance measurements.

3.4 METHODS OF ANALYSIS

3.4.1. Chemical analysis

3.4.1.1 pH

The pH of peda was determined by the method of Kosikowski (1982). The mashed samples of peda were filled in clean 100 ml glass beakers with gentle tapping so that no air pockets remained. The electrodes were inserted into the product at appropriate places. Averages of three pH readings were taken to establish the correct pH. The electrodes were cleaned after every observation.

3.4.1.2 Total solids

The total solid content in peda was determined by oven drying method as per the procedure outlined in IS: SP-18, 1981.

About 3 g of the prepared sample was accurately weighed in a previously dried and weighed flat bottomed aluminium dish (7-8cm in diameter) provided with a short glass stirring rod containing about 20 g prepared sand. Sand was saturated by the addition of a few drops of distilled water, mixed thoroughly with the glass rod and spread evenly for uniform evaporation of moisture. Dish was placed on a water bath for 20-30 minutes. After wiping the bottom, the dish was transferred to an oven at 102 ± 1^0C and heated for 4 hours. Process of heating, cooling and weighing was repeated till consecutive weighing did not differ by 0.5 mg.

$$\text{Total Solids , percent} = \frac{W_2 - W}{W_1 - W} \times 100$$

where

W is the weight of dish + sand + glass rod,

W_1 is the weight of sample + dish + sand + glass rod,

W_2 is the weight of residue + dish + sand + glass rod.

3.4.1.3 Titratable Acidity

About 1 g of the sample was accurately weighed into a porcelain dish. Ten ml of boiling distilled water was added and mixed well with the glass rod. The contents were cooled to room temperature, 1 ml of phenolphthalein indicator was added to it and titrated against 0.1N NaOH solution till a faint pink colour was obtained.

$$\text{Titratable Acidity (as lactic acid), per cent by mass} = \frac{9AN}{W}$$

where

A is the volume in ml of standard NaOH required for titration,

N is the normality of the standard NaOH solution,

W is the mass in g of peda taken for test.

3.4.1.4 Sucrose and Lactose

The sucrose and lactose were estimated essentially by the volumetric method of Lane-Eynon (IS: SP-18, Part-X1, 1981) prescribed for condensed milk

Forty grams of the well mixed sample was accurately weighed into a 100 ml beaker. Hot water at 80-90^{0}C was added to it, mixed and the contents were transferred to a 250 ml measuring flask, washing it with successive quantities of distilled water at 60^{0}C until the volume was 120-150 ml. The contents were mixed, cooled to room temperature and 5 ml of dilute ammonia solution was added. After proper mixing, it was allowed to stand for 15 minutes. The exact equivalent of dilute acetic acid to neutralise the ammonia was added and mixed. About 12.5 ml zinc acetate solution was added followed by 12.5 ml potassium ferrocyanide solution. The contents were mixed and made upto 250 ml. The precipitate was allowed to settle. It was filtered and the filtrate was marked as B_1.

Fifty ml of solution B_1 was pipetted into a 100 ml volumetric flask, 5 ml of concentrated hydrochloric acid was added and heated at 68^{0}C for 5 minutes. The solution was cooled and neutralised with NaOH solution. It was made upto 100 ml and marked as A_1.

Solutions A_1 and B_1 were diluted so that the volume of solution required for titration with 10 ml Fehling solution was between 15 and 50 ml. These were marked as A_2 and B_2 respectively. These solutions were filled in burettes and titrated against a mixture of 5ml each of Fehling A and Fehling B solutions in boiling using methylene blue as indicator. The titre values were noted down to compute sucrose and lactose.

$$\text{Sucrose, per cent by weight} = 25 \frac{W_1}{W_2} \left[\frac{2 f_2}{V_2} - \frac{f_1}{V_1} \right] \times 0.95$$

where

W_1 is the weight in mg of invert sugar corresponding to 10 ml of Fehling solution,

W_2 is the weight in g of the peda taken for the determination,

f_2 is the dilution factor for solution A_2 from A_1,

V_2 is the volume in ml of solution A_2 corresponding to 10 ml of Fehling solution,

f_1 is the dilution factor for solution B_2 from B_1,

V_1 is the volume in ml of solution B_2 corresponding to 10 ml of Fehling solution.

$$\text{Lactose, per cent by weight} = \frac{W_1}{V_1} \times \frac{250}{} \times \frac{f_1}{W_2} \times 100 \times \frac{1}{1000}$$

where,

W_1 is the weight in mg of lactose corresponding to 10 ml Fehling solution,

V_1 is the volume in ml of B_2 corresponding to 10 ml of Fehling solution,

W_2 is the weight in g of peda taken for analysis,

f_1 is the dilution factor for solution B_2 from B_1.

3.4.1.5 Protein

The protein content of peda was determined by micro Kjeldhal method according to IS: 1479, Part-II, 1961.The procedure in brief was as follows.

About 0.2 gm of peda was accurately weighed and transferred to the kjeldahl flask. About 0.5 gm of copper sulphate and about 5 gm of potassium sulphate and 25 ml of concentrated sulphuric acid were added to it. The contents were digested in a digestion unit until a clear and colourless solution was obtained. After cooling to room temperature, 50% NaOH solution was added to make the solution alkaline. The contents were steam distilled and the liberated ammonia was collected in 25 ml of saturated boric acid solution containing 2-3 drops of mixed indicator (methyl red and methylene blue). The distillation was continued until about 65-75ml of distillate was collected. This was titrated against N/35 H_2SO_4 until the grass-green colour changed to steel-gray, a further drop then giving purple colour. A blank was carried out using all reagents in the same quantities and with 0.5 g sucrose in place of the sample.

The protein was calculated by multiplying nitrogen by the factor 6.38

$$\text{Protein, per cent by weight} = \frac{8.932(B-A)\,N}{W}$$

where,

B is the volume in ml of standard sulphuric acid required for the test,

A is the volume in ml of standard sulphuric required for the blank test,

N is the normality of sulphuric acid,

W is the weight in g of peda taken for test.

3.4.1.6 Fat

The fat content of peda was determined by Mojonnier method (IS: SP-18, Part-X1, 1981).

Ten gram of peda was accurately weighed and transferred to a 100 ml beaker. About 30 ml of water was added to it and the mixture was boiled gently for about 3 minutes. The contents were cooled to about 20^0C and transferred quantitatively to a Mojonnier flask. Ten ml of ethyl alcohol was added to the beaker and transferred to the Mojonnier flask. This was followed by the addition

of 25 ml diethyl ether and 25 ml petroleum ether. The contents were mixed thoroughly and were allowed to stand still till the two layers separated completely. The upper ethereal layer was transferred to a pre weighed conical flask. The extraction was repeated twice using 15 ml of each solvent twice. The solvent was completely evaporated on a water bath. The fat was dried in an oven at 100 ± 1^0C.

$$\text{Fat, per cent by weight} = 100 \frac{(W_2 - W)}{W_1}$$

where

W_2 is the weight of conical flask+ residue after drying,

W_1 is the weight of sample taken,

W is the weight of conical flask.

3.4.1.7 Free fatty acids

The method described by Murthy (1983) was used to estimate the free fatty acid content of peda.

Fat was extracted from about 10 g peda by using diethyl ether and petroleum ether as solvents and its weight was measured. Ten ml of neutralised ethyl ether was added in to the flask containing the fat sample and the contents were mixed. (Ethyl ether was neutralised by washing with water 3 or 4 times, drying over anhydrous sodium sulphate and titrated against 0.02 N potassium hydroxide in methanol using 1% methanolic phenolphthalein as indicator.) The mixture was titrated with 0.02 N potassium hydroxide in methanol using 1% methanolic phenolphthalein as indicator.

The free fatty acid content was expressed as per cent oleic acid.

$$\text{Free fatty acid/ 100g fat} = \frac{0.282 \times V \times N}{W}$$

where

V is the volume of potassium hydroxide used for titration,

N is the normality of potassium hydroxide,

W is the weight in g of fat taken.

3.4.1.8 Total ash

About 3 gram of peda was accurately weighed in to a clean silica crucible. It was heated gently at first and then strongly for 1 hour in a muffle furnace at 550± 10 ^{0}C. The crucible was cooled in a desiccator and weighed. This process was repeated until the loss in weight between two successive weighings did not exceed 1 mg.

$$\text{Total ash, per cent by weight} = 100 \times \frac{W_2 - W}{W_1 - W}$$

where

W_2 is the weight in g of the crucible containing the ash,

W_1 is the weight in g of the crucible with the material taken for the test,

W is the weight in g of the crucible.

3.4.1.9 Browning

Pronase method of Palombo *et al.* (1984) was used with slight modification as outlined below: Calcium was avoided in the assay system. Tris-HCl buffer (0.05 M, pH 7.2) was used instead of tris-maleate buffer (pH 7.0).

The reagents for the analysis were prepared as outlined below.

(i) Tris-HCl buffer (pH 7.2)

Tris stock solution (6.25 ml of 2.42% Tris solution) was mixed with 5.75 ml of 0.02 M HCl. Water was added to make the final volume to 25 ml and the pH was noted.

(ii) Enzyme solution

Five mg of pronase, type XXV (pronase E) from Sigma Co USA was dissolved in 0.8 ml of tris-HCl buffer and used for each assay.

Browning index was determined according to the following procedure. Two gram of the peda was accurately transferred to a mortar and pestle and

grounded well to a paste with addition of small amounts of tris buffer intermittently. The sample was quantitatively transferred to a 25 ml volumetric flask and mixed thoroughly. Three ml of the suspension was pipetted into a test tube and to this 0.8 ml of enzyme solution was added. The contents were incubated at 45^0C for $2^1/_2$ hours. After incubation, the test tube was chilled in water bath, 0.3 ml of 100% TCA (w/v) added, and was centrifuged at 7,000 rpm for 15 minutes. It was then filtered through Whatman No.1 filter paper. The filtrate was used for the spectrophotometric determination. For blank, distilled water was used instead of sample suspension.

The optical density of the clear filtrate was determined on a spectrophotometer at wavelengths 420 nm and 550 nm.

Browning was calculated as: $A = A_{420nm} - A_{550nm}$

For practical purpose the browning index was expressed as A/g of dry solids.

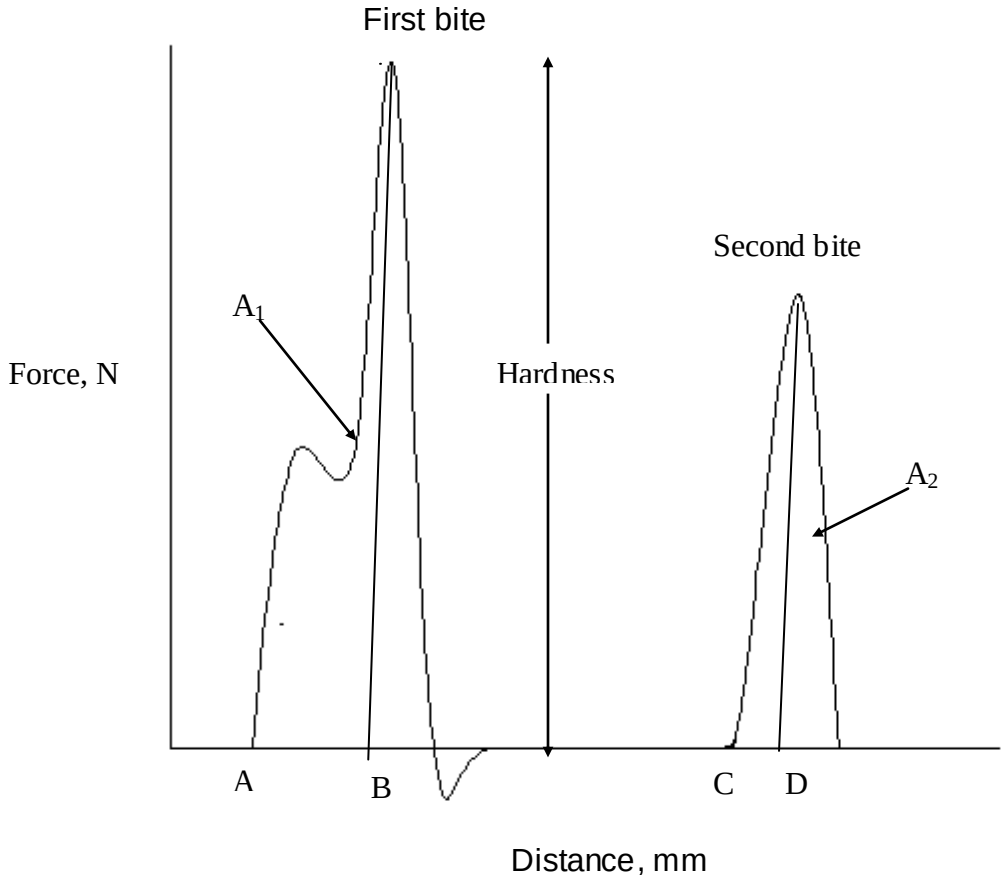
3.4.2 Rheological analysis

The rheological analysis of peda was done using Texture analyser. The following. TA-XT plus settings were selected

Pre-test-speed	:	1.00 mm/sec
Test-speed	:	5.00 mm/sec
Post-test speed	:	5.00 mm/sec
Target mode	:	Distance
Distance	:	7.5 mm
Time	:	5.00 sec
Trigger type	:	Auto (Force)
Trigger force	:	0.01961 N
Tare mode	:	Auto
Advanced options	:	ON

Before starting the test, the probe (P/25) was calibrated to a distance of 50 mm, from the base of the platform. Sample was cut to 1cm x1cm x 1cm size and kept on the platform. Probe was positioned centrally over the sample surface and allowed to compress the product. The probe travelled to a distance of 7.5 mm into the product and returned to original position, generating a force-time curve. All tests were conducted at the same temperature.

A typical 2 – bite, force distance compression curve for peda obtained on TA-XT plus texture analyser is shown below.



Hardness is the force necessary to attain a given deformation. It is represented by the maximum force on the 1st peak of a TPA curve. Cohesiveness is the ratio of area under the second bite curve before reversal compression (A_2 in figure) to that under the first bite curve (A_1 in figure).

Springiness refers to the height that the same recovers during force relaxation time between first and second compression cycle ((C-D)/(A-B) in the above figure). Gumminess is related to the primary parameters of hardness and cohesiveness and is obtained by multiplication of these two parameters. Chewiness refers to the energy required to masticate food into a state ready for swallowing and is the product of hardness, cohesiveness and springiness (Patel *et al*. 2006).

3.4.3 Sensory evaluation

The sensory evaluation of peda was done by an expert panel of judges on a 9 point hedonic scale wherein a score of 1 represented “disliked extremely’ and a score of 9 represented “liked extremely”. The samples for evaluation were coded appropriately during sensory evaluation.

3.4.4 Statistical analysis

Data obtained during the present project work were subjected to statistical analysis described by Snedecor and Cochran (1994), and employing appropriate computer packages.

4.0 RESULTS AND DISCUSSION

The results of the study conducted to characterise Dharwad Peda are presented in this chapter.

4.1 FEATURES OF DHARWARD PEDA

A survey of the Dharwad market revealed that there were different brands of Dharwad Peda reputed to be made by traditional processes using local expertise developed. Samples of 7 popular brands were collected for characterization of the product. All the samples were typically brown in colour with a coating of powdered sugar. The samples were mostly cuboid in shape, but some were round and flat. Individual sweet pieces of the same brand, weighing about 20-25g each, were not of uniform size or shape indicating that they were not prepared in any mould. The samples had a soft but uniform body. Their texture was, generally, granular.

Samples of peda sold as 'Dharwad Peda' but produced outside Dharwad, varied widely in colour, appearance, body and texture. As in the case of traditional Dharwad Peda, the shape of the individual pieces varied from cuboids to round and flat. Their colour ranged from yellowish brown to reddish brown. It was obvious that some of the manufacturers had tried to imitate traditional Dharwad Peda by adding colour to their products. Some samples had too soft a body that they deformed easily. Some samples had pasty texture while others were granular. Thus, the 'Dharwad Peda' produced outside Dharwad had less uniformity in colour, appearance and texture compared to popular traditional Dharwad Peda. The distinguishing colour and appearance of traditional Dharwad Peda is revealed in Figure1.

The other varieties of peda collected from different places, for characterization included normal doodh peda, kesar, karpoor and malai peda. Samples of doodh peda were of whitish yellow colour with soft and pasty body and had typical khoa flavour. The malai peda and karpoor peda were similar to

doodh peda except that their flavours were different. Kesar peda was yellowish in colour. The samples in this group differed mostly in the flavour and colour added to the product.

While traditional Dharwad Peda possessed its district brown colour and characteristic caramelized and cooked flavour through browning reaction during its production (Kulkarni and Unnikrishnan, 2006), colour and flavour characteristics of other varieties of peda appeared to depend mostly on the additives used.

4.2 BROWNING INDEX

Since colour was found to be one of the most distinguishing features of Dharwad Peda, an attempt was made to quantify the colour through browning index (BI). For this purpose, the colour had first to be extracted. The main factor limiting the extraction of brown pigments from dairy products is the formation of complexes of protein – pigments (Goldblith and Tannenbaum, 1966). Break down of the protein molecules by proteolytic enzymes helps to extract the pigments bound to the protein efficiently (Choi *et al*., 1949; Labuza and Saltmarch,1981 and Palombo *et al*.,1984). Therefore, this procedure was adopted for quantifying the browning in the products. However, this procedure suffered from the limitation that it could not be used in samples that contained added colour. The colour added externally was easily extractable with hot water or acid whereas the colour produced during manufacture as a result of browning reactions remained mostly unextracted with this treatment. Therefore, this served as a method for distinguishing natural browning from colour addition. The measurements of BI was restricted to samples which did not show added colour.

BI of Dharwad Peda samples in comparison to other varieties is presented in Table 1. The average value of BI for traditional samples was 1.31. Peda produced elsewhere and sold as ‘Dharwad Peda’ too had similar index of 1.44. The other varieties of peda had significantly lower average BI of 0.16.

Traditional Dharwad Peda

"Dharwad Peda" prepared outside Dharwad

Other varieties

Figure 1: Photographs of varieties of Peda

Table 1: Browning Index of varieties of peda samples (OD/g dry solids).

Sample No.	Dharwad Peda produced in Dharwad	'Dharwad Peda' produced elsewhere	Other varieties of peda
1	1.01	1.01	0.13
2	1.33	0.83	0.11
3	0.94	2.25	0.13
4	0.99	1.81	0.13
5	1.34	2.06	0.15
6	1.24	1.84	0.17
7	1.25	1.67	0.13
8	1.24	1.54	0.10
9	1.25	0.49	0.23
10	1.28	1.01	0.46
11	1.94	1.26	0.12
12	1.91	1.49	0.11
13	1.10	-	0.12
14	1.45	-	0.12
Mean±SD	1.31±0.3	1.44±0.53	0.16±0.09

Rajorhia and Srinivasan (1974) had noticed that preparation of khoa from cow or buffalo milk was accompanied by progressive loss of lactose and development of brown colour and intense cooked flavour. Further heat processing increases the browning. The higher value of BI for Dharwad Peda can be attributed to the prolonged heat treatment in its production process.

The chemistry of browning is highly complex and has been reviewed by numerous authors (Danhey and Pigman, 1951; Hodge, 1953; Andrian, 1974; Shibamoto, 1983; O'Brein and Morressy, 1989, Gothwal, 1990). Both caramelization and Maillard browning can occur in dairy products. Caramelisation is heat decomposition of sugars as a function of pH and buffer in the absence of

amino compounds. It requires relatively high order of activational energy (Jenness and Patton, 1959). The first step involves conversion of the carbohydrate to 1, 2 – enediols, which upon further heating undergo dehydration reactions, leading to the formation of 5- hydroxy methyl furfurals. Polymersation of furfural derivatives leads to formation of coloured pigments (Cui, 2005).

In Maillard browning, the reducing sugar reacts reversibly with an amine that eventually leads to the formation of 5-hydroxymethyl – 2- furaldehyde (HMF). Under the acidic conditions, HMF and other cyclic compounds polymerize quickly to a dark coloured insoluble material (Fenamma, 1996). Browning reactions are markedly increased with increase in pH. Even though the pH of Dharwad Peda was lower than that of other varieties, it had significantly higher browning. This indicates the severe heat treatment the product had undergone.

Browning reactions impart not only the characteristic colour, but also flavour and increased shelf life to Dharwad Peda. Among the numerous products that are formed near the end of the Maillard reactions are low molecular weight substances which have sufficient volatility for odour (Hodge, 1953). Some of the most pleasant caramel like aromas are derived from process reactions by compounds with planar enol-cylic ketone structure. (Fenemma, 1996). Dharwad Peda produced traditionally has typical caramel flavour.

Maillard reactions lead also to formation of compounds with enediol structure which can easily be oxidized like reductones. The products are effective in reducing peroxides, inactivating radicals as well as in complexing of heavy metals (Yamuchi and Koyama, 1967). This explains, in part, the longer shelf life reported for Dharwad Peda (Kulkarni and Unnikrishnan, 2006).

4.3 SENSORY ATTRIBUTES

A comparative appraisal by a panel of judges, of the appearance, body and texture, flavour and overall acceptability revealed that the products from Dharwad outscored in all these respects except that one brand of the product collected from Bangalore market scored as well as the products from Dharwad. The range and average scores with respect to each attribute is presented in

Table 2. The products from Dharwad showed superiority especially in flavour. As mentioned earlier, some samples of peda sold as 'Dharwad Peda', but produced elsewhere contained colour and flavour additives to imitate the traditional product. However, such additives could not give the products the described quality and acceptance.

Table 2: Sensory score of Dharwad Peda

Sensory attribute	Dharwad Peda produced by traditional technology	'Dharwad Peda' produced elsewhere
Appearance	6.4 – 8.3 (7.2)	5.4 – 7.5 (6.5)
Body and texture	6.4 – 8.4 (7.0)	5.0 – 7.4 (6.3)
Flavour	6.0 – 8.4 (7.1)	5.1 – 7.7 (6.1)
Over all acceptability	6.3 – 8.3 (7.1)	5.2 – 7.6 (6.3)

- The figures in brackets indicate average of 5 values.

4.4 RHEOLOGICAL PROPERTIES

Rheological properties of Dharwad Peda as measured by TA-XT plus Texture analyser revealed that the traditional product was distinct from other varieties of peda. Mean values of hardness, cohesiveness, gumminess, springiness, and chewiness of traditional Dharwad Peda and other varieties are given in Table 3.

Table 3: Rheological characteristics of peda

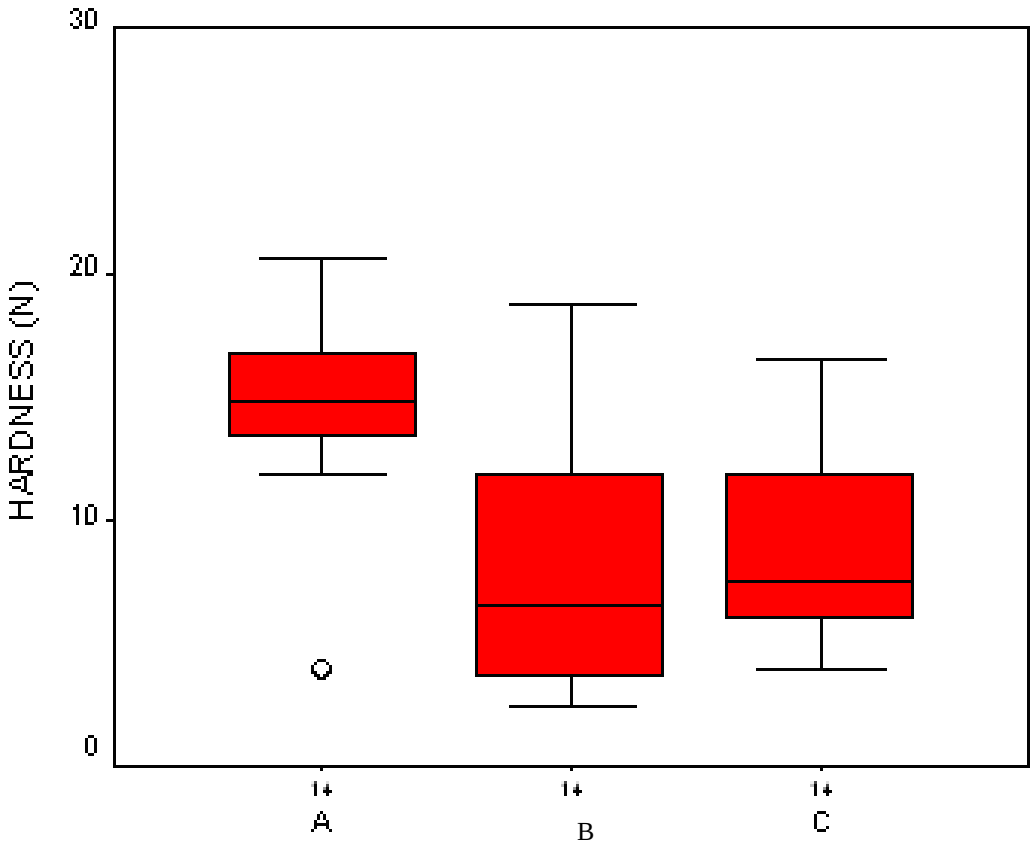
Sl. No.	Parameters	Dharwad Peda produced in Dharwad	'Dharwad Peda' produced elsewhere	Other varieties of peda
1.	Hardness (N)	15.22 ± 2.43	8.37 ± 5.55	8.92 ± 3.99
2.	Cohesiveness	0.16 ± 0.03	0.12 ± 0.03	0.14 ± 0.07
3.	Gumminess (N)	2.45 ± 0.42	0.9 ± 0.45	1.26 ± 1.04
4.	Springiness (mm)	0.22 ± 0.04	0.16 ± 0.03	0.18 ± 0.048
5.	Chewiness (N.mm)	0.55 ± 0.16	0.15 ± 0.08	0.21 ± 0.14

A comparison of the rheological properties of peda is presented in the form of box plots (Figure 2-6). In the box plots, the results are presented in terms of median and percentiles. The hinges on the top and bottom of the box show the upper and lower quartile. The median is indicated by a black line inside the box. The horizontal lines, above and below the boxes mark the adjacent values. These are the most extreme values in the group that lie between the hinges and the inner fences. Data points outside the points should be considered as 'outliers'. Outliers are marked with a circle and extreme cases with asterisks. The small numbers below the x-axis show the number of data points which were used to make up the box directly above it.

Hardness value of Dharwad Peda was significantly higher ($P \leq 0.05$) than that of other varieties. The mean hardness value (N) of the traditional product was 15.22 as against the value of 8.92 for the other varieties. The box plots (Figure 2) reveal that different brands of the traditional product had not only higher hardness but also more uniformity in hardness than the products in the other two groups.

The mean value of cohesiveness was found to be slightly higher in the case of Dharwad Peda. However, the difference among the three groups of

peda samples was not statistically significant (Figure 3). This was probably due to the wide range of values noted for other verities of peda. Dharwad Peda

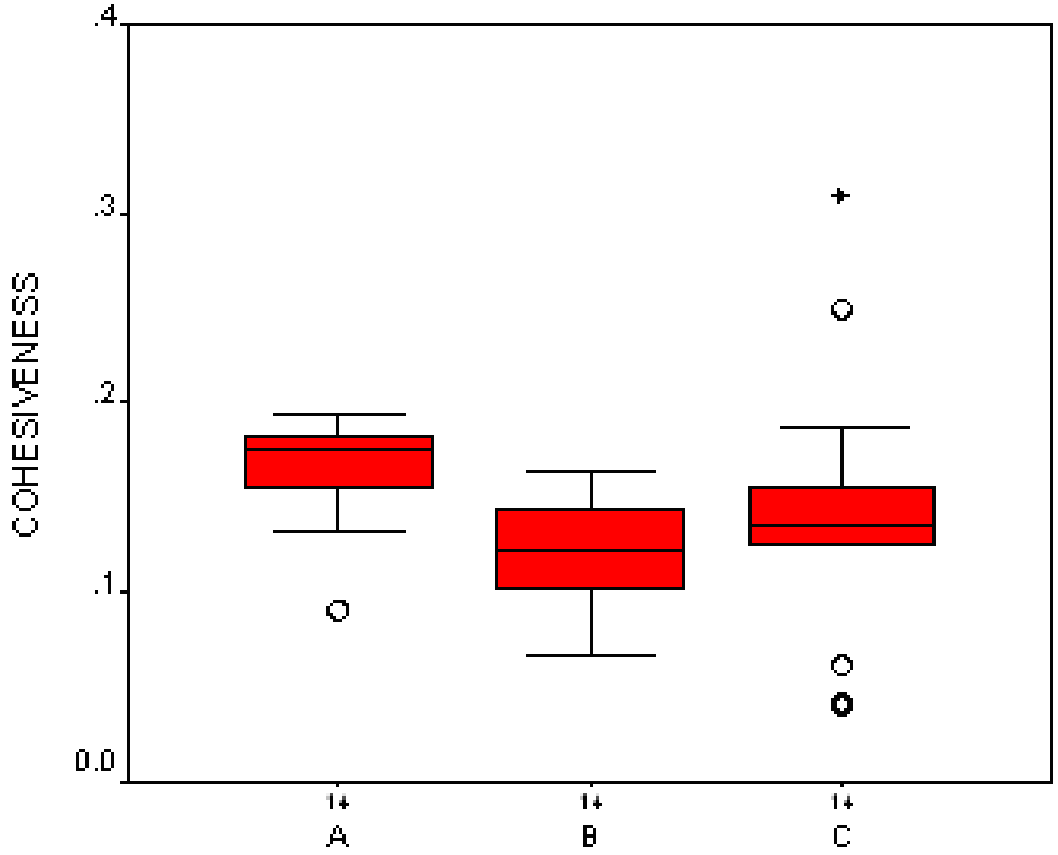


A- Dharwad Peda produced in Dharwad

B- 'Dharwad Peda' produced elsewhere

C- Other varieties of peda

Figure 2: Box plots of hardness of peda

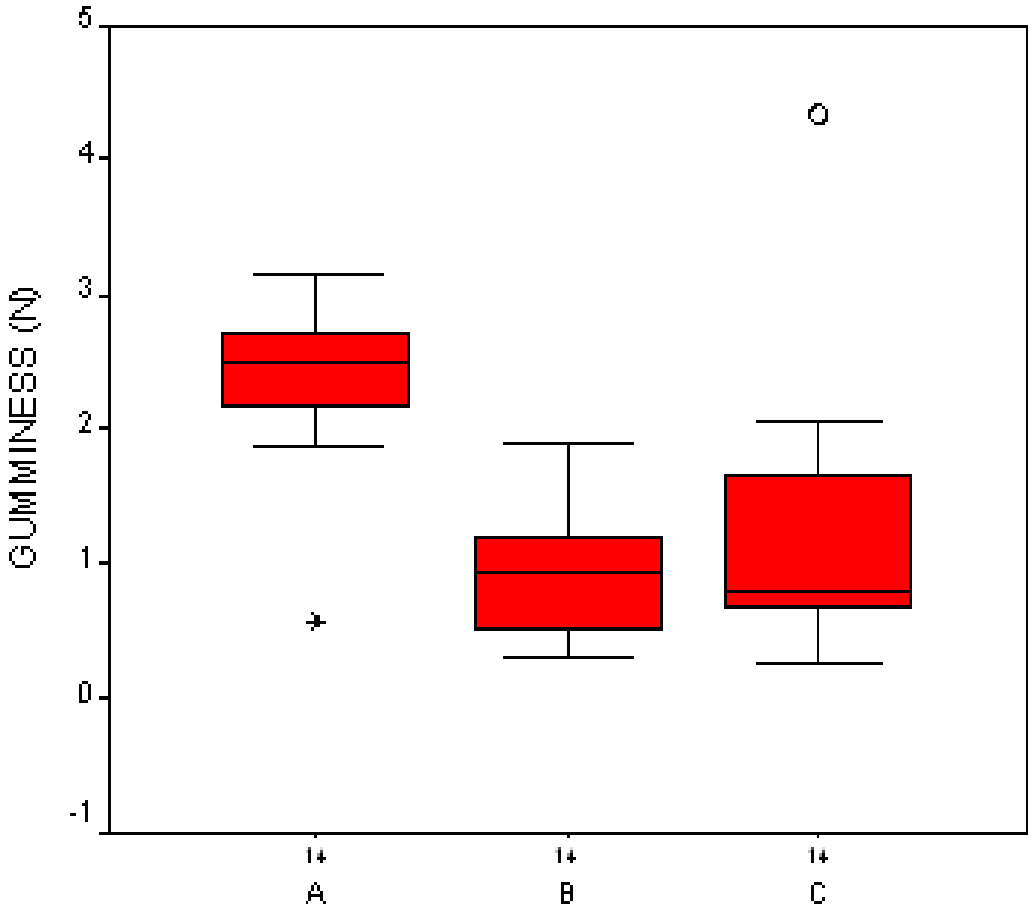


A- Dharwad Peda produced in Dharwad

B- 'Dharwad Peda' produced elsewhere

C- Other varieties of peda

Figure 3: Box plots of cohesiveness of peda

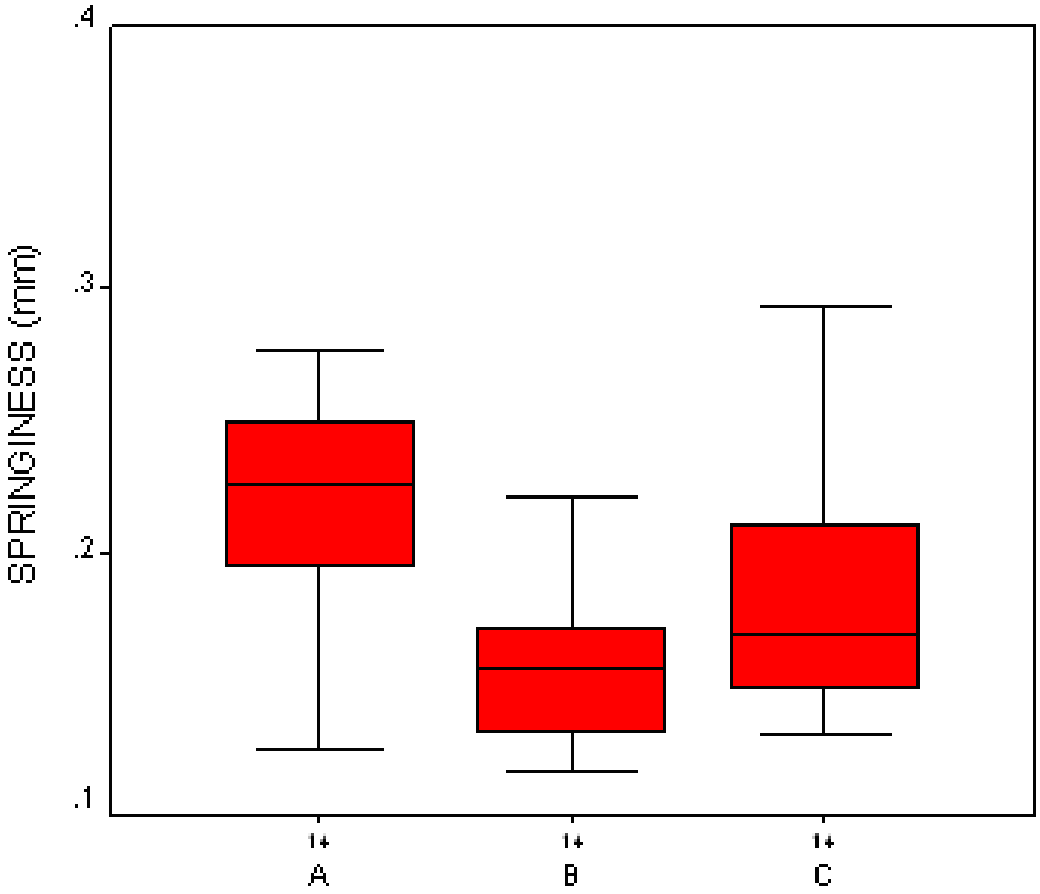


A- Dharwad Peda produced in Dharwad

B- 'Dharwad Peda' produced elsewhere

C- Other varieties of peda

Figure 4: Box plots of gumminess of peda

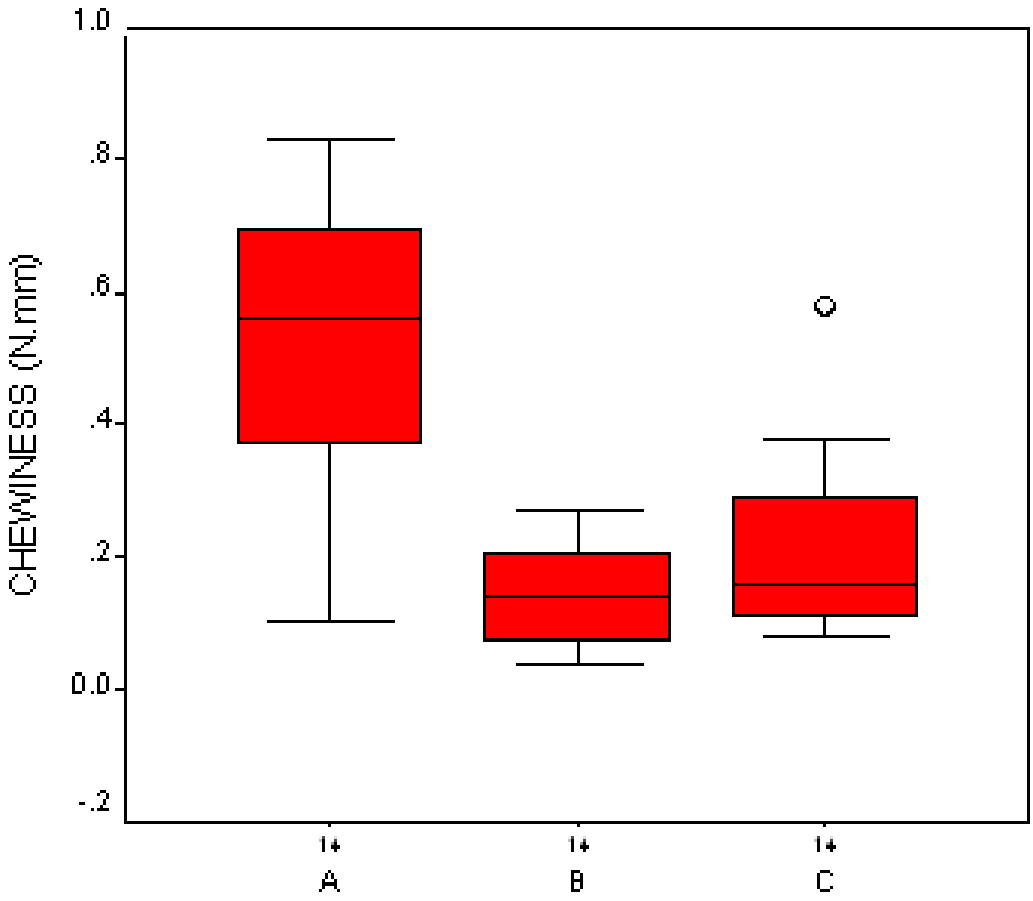


A- Dharwad Peda produced in Dharwad

B- 'Dharwad Peda' produced elsewhere

C- Other varieties of peda

Figure 5: Box plots of springiness of peda



A- Dharwad Peda produced in Dharwad

B- 'Dharwad Peda' produced elsewhere

C- Other varieties of peda

Figure 6: Box plots of chewiness of peda

showed more gumminess than other varieties (Figure 4). The difference was significant ($P \leq 0.05$). However, no significant difference was noticed between samples sold as 'Dharwad Peda' but produced elsewhere and the samples of other varieties of peda.

As in the case of gumminess, springiness was also higher for Dharwad Peda, but 'Dharwad Peda' produced elsewhere had springiness similar to other varieties of peda (Figure 5).

Another significant difference of Dharwad Peda in rheological property was with respect to its chewiness. The traditional product had a mean chewiness (N.mm) of 0.55, which was about 2-3 times the value for other varieties. Box plots (Figure 6) show that unlike the case with other parameters, samples of the traditional products showed more variation in chewiness than products of the other groups.

Thus, from the rheological analysis it could be concluded that traditional Dharwad Peda had distinctly higher hardness, gumminess, springiness and chewiness than other varieties of peda. Though cohesivenss too was found to be higher for Dharwad peda, statistical analysis did not show the difference to be significant probably because of the wide range of values noted for other varieties of peda. Differences in both compositional factors and processing conditions could have contributed to these distinct differences in rheological properties of Dhaward Peda from other varieties.

4.5 CHEMICAL COMPOSITION

The chemical analysis of the peda samples and statistical analysis of the data collected, revealed differences in the levels of some ingredients of the three groups – traditional Dharwad Peda, 'Dharwad Peda' produced elsewhere and other varieties. The range, mean and standard deviation of the levels of major constituents of the products are presented in Tables 4 - 6. Marked differences in the composition of peda from different regions of the country have been reported (Reddy and Rajorhia, 1992). In the present study, comparison of the composition

of Dharwad Peda with the other varieties was restricted to the samples collected from local market.

Table 4: Chemical composition of Dharwad Peda produced in Dharwad

Constituent	Minimum (%)	Maximum (%)	Mean ± SD
Fat	12.00	16.40	14.21 ±1.40
Protein	10.50	16.53	14.17± 1.70
Lactose	15.38	19.43	17.37± 1.24
Sucrose	34.01	48.40	38.97± 3.60
Ash	2.28	3.26	2.80±0.32
Moisture	9.20	14.48	13.33± 1.30

Table 5: Chemical composition of 'Dharwad Peda' produced elsewhere

Constituent	Minimum (%)	Maximum (%)	Mean± SD
Fat	9.20	19.00	15.37± 2.47
Protein	8.00	16.53	13.53± 1.86
Lactose	12.27	21.90	17.11± 2.48
Sucrose	30.34	53.02	37.95± 5.25
Ash	1.48	3.42	2.75± 0.55
Moisture	7.90	19.64	13.51± 2.99

Table 6: Chemical composition of other varieties of peda

Constituent	Minimum (%)	Maximum (%)	Mean± SD
Fat	9.20	21.00	16.74± 2.80
Protein	11.61	19.47	15.23 ± 1.70
Lactose	12.10	22.19	17.43± 1.83
Sucrose	27.65	57.90	34.38± 6.42
Ash	1.80	3.42	2.89± 0.37
Moisture	7.90	17.10	13.63±1.66

For the sake of easy comparison of the contents of Dharwad Peda, with those of other varieties, the levels of major constituents are presented in bar charts and box plots (Figures 7 - 18). In bar charts, the averages of the levels and standard deviation of the individual constituents are presented and the box plots indicate the median and spread of samples. These figures would reveal that though statistically difference existed between the mean levels of major constituents of Dharwad peda and other varieties, ranges of levels of individual components of the different groups often overlapped each other.

4.5.1 Fat

The fat contents of Dharwad Peda samples varied in a comparatively narrow range of 12.0% to 16.4% with an average content of 14.21%. A wider range in fat content was noticed in other varieties of peda. The range was from 9.2 to 21.0% with a mean value of 16.74%. Wide variations in the level of fat was noticed also in the samples of peda produced elsewhere but sold as 'Dharwad Peda' (Figure 7), the range being 9.2 to 19.0%. Though there was some overlapping, majority of the samples of other varieties had higher fat content than the maximum noted for any sample of Dharwad Peda (Figure 8). Statistical

analysis showed that the mean level of fat in Dharwad Peda was significantly lower than that of other varieties collected for the present study.

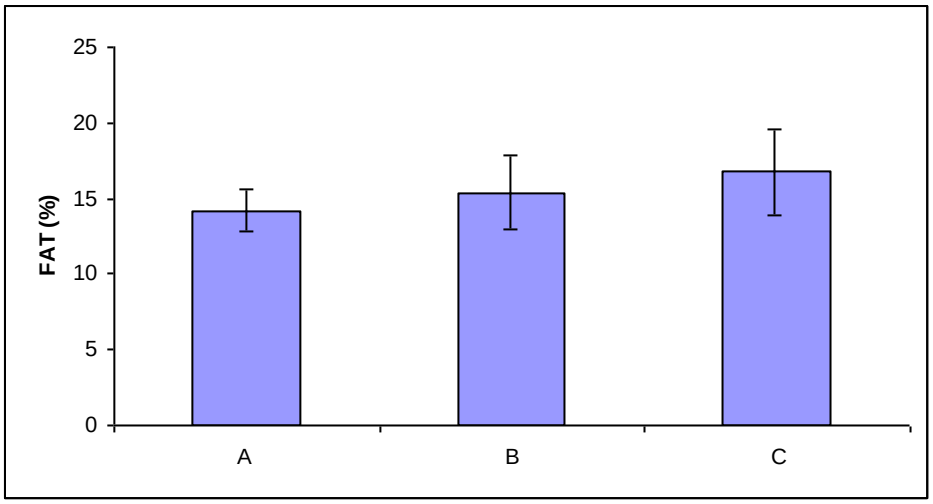
However, Dharwad Peda cannot be considered as having lower fat content than the other varieties sold in different regions of the country when we take into account the published results. Sharma and Zariwala (1978) had reported a range of 7 to 25% of fat in market peda samples from Bombay. Vijayakhader and Patel (1983) had noted a fat content of 14.4% only in peda sold in Anand. Ray *et al.* (2002) found that fat content of market Peda from Kolkata was 14.12.± 1.98% only. These values are similar to the one noted for Dharwad Peda in the present study.

Garg and Mandokhot (1984, 1987) on the other hand, found a much higher fat content of 20.06% and 23.52% respectively in the peda samples from Hissar and Hansi markets. Reddy and Rajorhia (1992) reviewed the reports on fat contents of market peda from different places and had found values ranging from 3.2 to 21.7%. Kumar *et al.* (1997) too found 18% fat in peda from Sugam Dairy, Baroda. Sharma *et al.* (2003) reported a fat content of 19.4% on dry basis, in malai peda supplied by a trader in Mumbai. This figure is similar to the fat content found for other varieties of peda in the present study. Patel *et al*., (2006) compared the fat content of market samples of peda from 5 cities of Gujarat prepared by traditional method and that prepared by mechanical method. They found 21.1% fat on dry basis in peda manufactured by the traditional method and 17.4% in the mechanized product.

These reports suggest that though in the present study, fat content was found to be lower in Dharwad Peda than in other varieties, it cannot be taken as a distinguishing feature of the product.

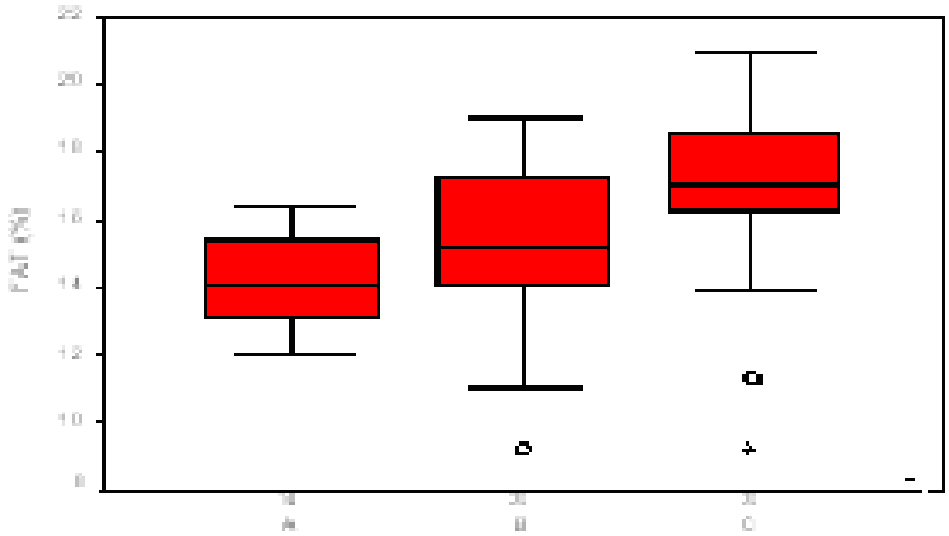
4.5.2 Protein

The protein content of Dharwad Peda produced in Dharwad was found to be in the range of 10.5% to 16.53% with an average value of 14.17±1.7%. Similarly wide range in protein was observed in other varieties and samples of peda produced elsewhere but sold as 'Dharwad Peda'. The range was 11.61%



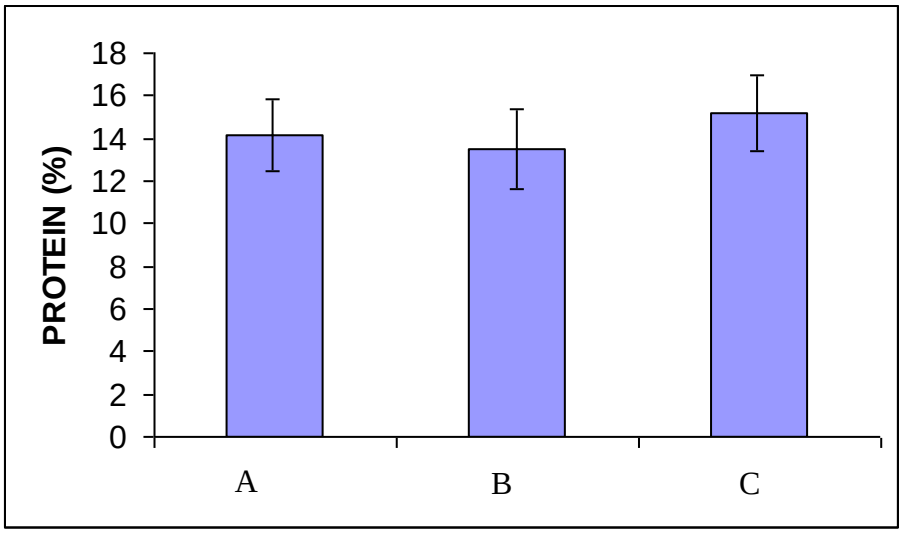
A – Dharwad Peda produced in Dharwad, B – 'Dharwad Peda' produced elsewhere
C – Other varieties of peda

Figure 7: Mean and standard deviation of fat content of peda



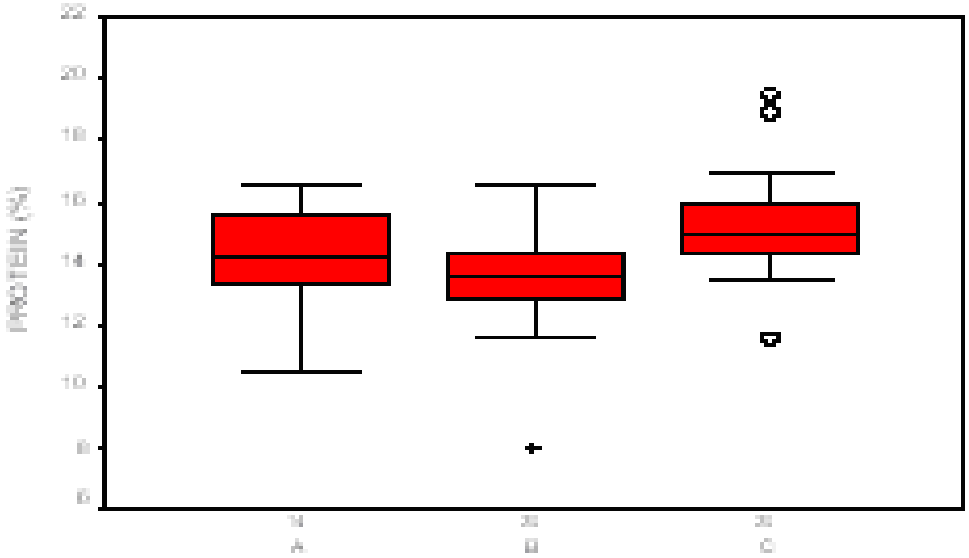
A – Dharwad Peda produced in Dharwad, B – 'Dharwad Peda' produced elsewhere
C – Other varieties of peda

Figure 8: Box plots of fat content of peda



A – Dharwad Peda produced in Dharwad, B – 'Dharwad Peda' produced elsewhere
C – Other varieties of peda

Figure 9: Mean and standard deviation of protein content of peda



A – Dharwad Peda produced in Dharwad, B – 'Dharwad Peda' produced elsewhere
C – Other varieties of peda

Figure 10: Box plots of protein content of peda

to 19.47% and 8.0% to 16.53% respectively (Tables 5 & 6). Most of the samples of other varieties had higher protein content than samples of peda sold as "Dharwad Peda" and there was considerable overlapping between other varieties of peda and traditional Dharwad Peda (Figure 10). Statistical analysis showed that the mean level of protein in Dharwad Peda was significantly lower than that of other varieties collected for the present study (Figure 9).

Even though the protein content of Dharwad Peda obtained in the present study was lower, several published results reveal that other varieties of peda with much lower protein content are being sold in different parts of country. Sharma and Zariwala (1978) had reported a range of 1.4 to 12.1% of protein in market peda samples from Bombay. Vijayakhader and Patel (1983) found a protein content of 11.1% in peda from Anand. Garg and Mandokhot (1984) found that the protein content of peda from Hissar and Hansi Market was 13.77%. Reddy and Rajorhia (1992) reviewed the reported protein contents of market peda from different places and found values ranging from 1.4 to 19.5%. Kumar *et al.* (1997) found 12.09% protein in laboratory made kesar peda. Ray *et al*. (2002) found that protein content of market samples of peda sold in Kolkata was 15.26±0.32%. This value is similar to the protein content found for other varieties of peda in the present study. Sharma *et al*. (2003) reported a protein content of 19.4% on dry basis, in malai peda obtained from Mumbai. Patel *et al.* (2006) found a protein content of 16.8% on dry basis for peda manufactured by traditional technology and 17.6% for peda manufactured by mechanized method.

Therefore, as in the case of fat, the difference in the protein content noted in the present study cannot be taken as a distinguishing feature of Dharwad Peda.

4.5.3 Lactose

The lactose content of Dharwad Peda samples varied in a comparatively narrow range of 15.38% to 19.43% with an average value of 17.37±1.24%. Wider range was obtained in the lactose content of other varieties where it varied from 12.16% to 22.19% with an average value of 17.43±1.83%. Wider range in the

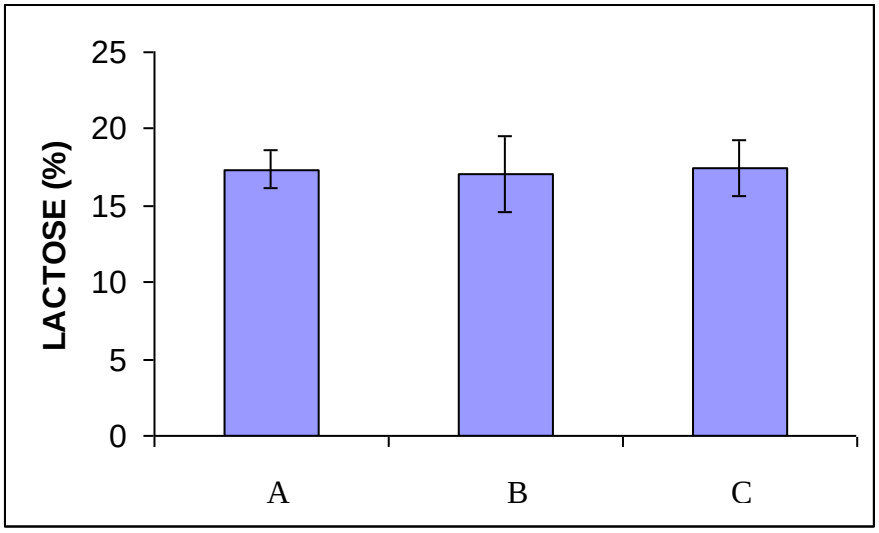
lactose content was also noticed in peda produced elsewhere but sold as 'Dharwad Peda', the range being 12.27% to 21.9% (Tables 4-6). There was considerable overlapping in the values of lactose from different groups (Figure 12). Statistical analysis showed that the mean level of lactose in Dharwad Peda was not significantly different from that in other varieties of peda (Figure 11).

Sharma and Zariwala (1978) reported that lactose content of samples of market peda in Bombay was 4.1 to 18.6%. Vijayakhader and Patel (1983) reported low (6.5%) lactose in a market peda sample from Anand but Garg and Mandokhot (1987) reported an average lactose content of 9.4% in market samples from Hissar and Hansi. Ray *et al*. (2002) found a lactose content of 12.92 ±1.75% in market samples sold in Kolkata. Pate *et al.* (2006) compared the lactose content of peda samples sold in 5 cities of Gujarat. They found a lactose level of 15.7% in traditionally made samples and 16.6% in peda made by mechanical methods.

4.5.4 Sucrose

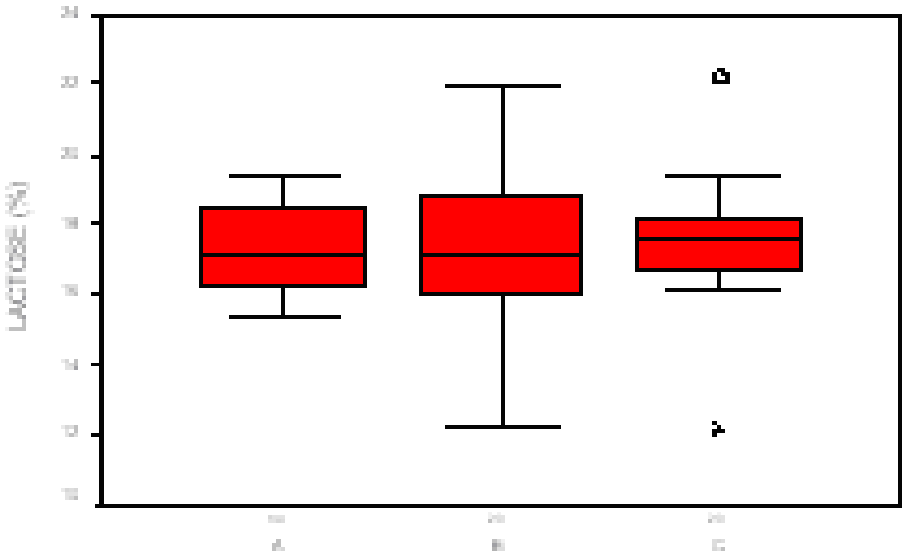
The sucrose content of Dharwad Peda samples varied between 34.01% and 48.4% with an average value of 38.97±3.6%. Wider variation was seen in the sucrose content of other varieties of peda, the range being 27.65% to 57.9% with an average value of 34.38±6.42%. Wider variation in sucrose was also noticed in samples of peda produced elsewhere but sold as 'Dharwad Peda'. The range was 30.34% to 53.02% (Tables 4-6). Statistical analysis showed that the mean level of sucrose in Dharwad Peda was significantly higher than that of other varieties of peda collected (Figure 13 and 14). Apart from the higher sucrose level that could have been used during the desiccation process, coating of powdered sugar on the surface of the product too would have contributed to the higher level of sucrose in Dharwad Peda.

However, the published results revealed a wide range in the sucrose content of different varieties of peda from market. Sharma and Zariwala (1978) found sucrose contents of samples of market peda from Bombay to range from 13.2% to 61.8%. Ray *et al*. (2002) found a sucrose content of 42.69±1.85% in



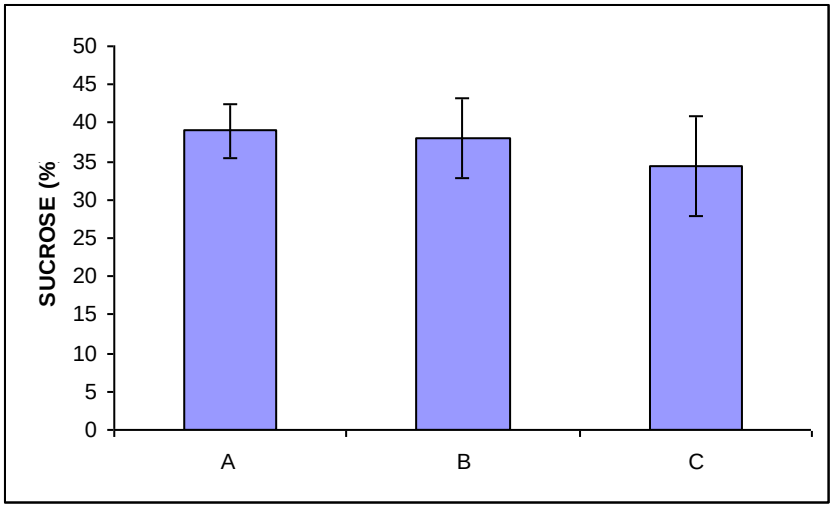
A – Dharwad Peda produced in Dharwad, B – 'Dharwad Peda' produced elsewhere
C – Other varieties of peda

Figure 11: Mean and standard deviation of lactose content of peda



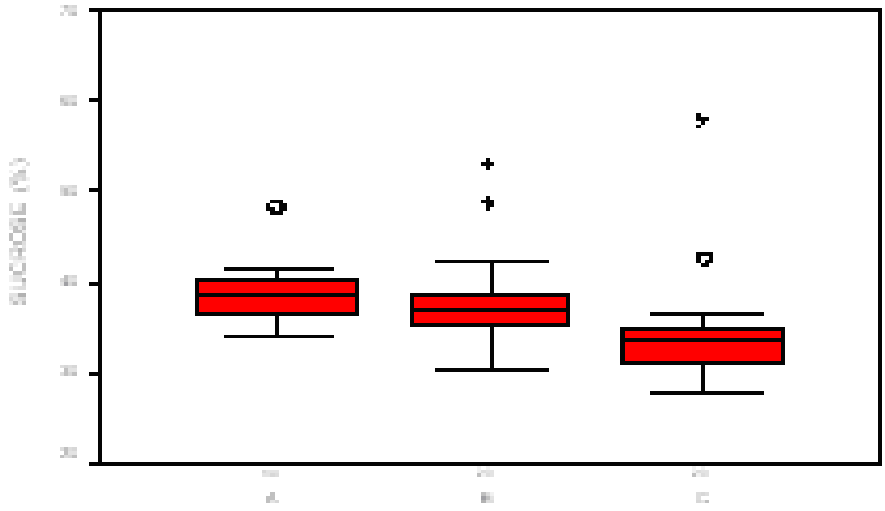
A – Dharwad Peda produced in Dharwad, B – 'Dharwad Peda' produced elsewhere
C – Other varieties of peda

Figure 12: Box plots of lactose content of peda



A – Dharwad Peda produced in Dharwad, B – 'Dharwad Peda' produced elsewhere
C – Other varieties of peda

Figure 13: Mean and standard deviation of sucrose content of peda



A – Dharwad Peda produced in Dharwad, B – 'Dharwad Peda' produced elsewhere
C – Other varieties of peda

Figure 14: Box plots of sucrose content of peda

samples of peda sold in Kolkata. Sharma *et al.* (2003) reported 39.5% sucrose in malai peda sold in Mumbai. Patel *et al.* (2006) reported 35.2% and 34.4% of sucrose in peda samples manufactured by traditional method and mechanized method respectively from Gujarat. This value is similar to that obtained for other varieties of peda in the present study.

Garg and Mandokhot (1987) and Kumar *et al.* (1997) reported lower sucrose content of 29.0% and 29.1% respectively for samples of peda from Hissar and Hansi and kesar peda manufactured in Sugam Dairy, Baroda. Reddy and Rajorhia (1992) who had reviewed the earlier reports found a wide range in the reported values of sucrose content in samples of peda sold in different parts of the country. The range was 13.2 to 61.8%. However, the content of most of the samples fell in the range of 30 to 40%. Samples with high sucrose content had low milk solids which affected their quality.

More than the sucrose content, it was the coating of powdered sugar on the surface of the product that helped to distinguish Dharwad Peda from other varieties.

4.5.5 Moisture

The moisture content of Dharwad Peda varied in a comparatively narrow range of 9.2% to 14.48% with an average value of 13.33±1.3%. Wider variation was observed in the moisture content of other varieties of peda. The range was 7.9 to 17.1% with an average value of 13.63±1.66%. Wider variation was also observed in samples of peda sold as 'Dharwad peda' but produced elsewhere, the range being 7.9% to 19.64% (Figure 15). Since there was considerable overlapping, there was no significant difference in the moisture content of peda samples (Figure 16) of the different groups taken up for this study. Kulkarni and Unnikrishnan (2006) had reported 12-14% moisture in Dharwad Peda.

Several reports have been published regarding the moisture content of peda sold in different parts of the country. Sharma and Zariwala (1978) reported a wide range (4.2% to 14.2%) in the moisture content of samples of peda sold in Bombay market. Vijayakhader and Patel (1983) found a lower value of 10.8% in

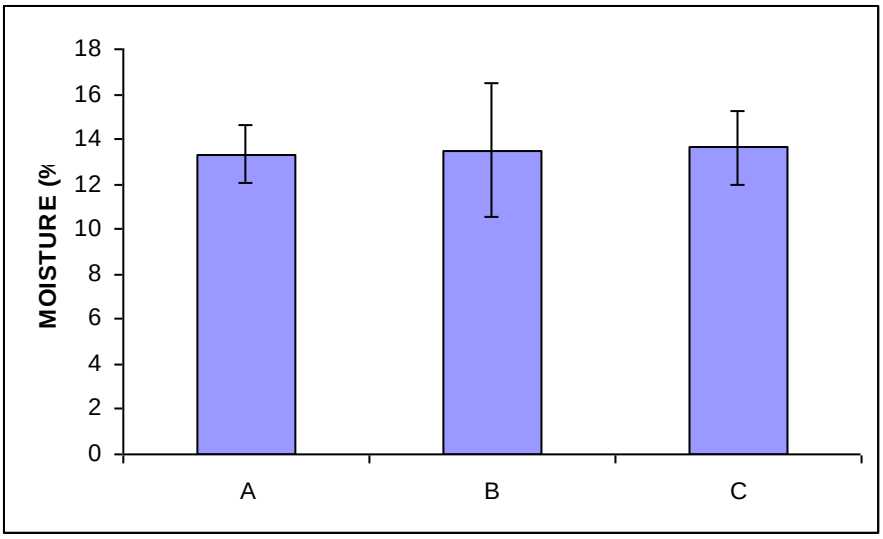
the peda from Anand. Garg and Mandokhot (1984, 1987) reported 14.99% and 13.75% for samples from Hissar and Hansi. Kumar *et al*. (1997) found 17.83% moisture in peda samples prepared in Sugam Dairy, Baroda. Ray *et al*. (2002) observed 14.73 ± 2.75% moisture in peda samples from Kolkata. A much higher value of 25.4% was reported by Sharma *et al.* (2003) in samples of malai peda prepared in laboratory. Patel *et al.* (2006) reported 13% and 14.4% of moisture in peda prepared by traditional method and mechanized method respectively.

It is reported that special features of Dharwad Peda are in part due to a prolonged heat treatment that the product undergoes during the desiccation process and that the product has a shelf life of 7-10 days at ambient temperature and about a month at refrigerated temperature due to its low water activity (Kulkarni and Unnikrishnan, 2006). It was expected, therefore, that Dharwad Peda would have a lower moisture content compared to other varieties. This was not the case.

4.5.6 Ash

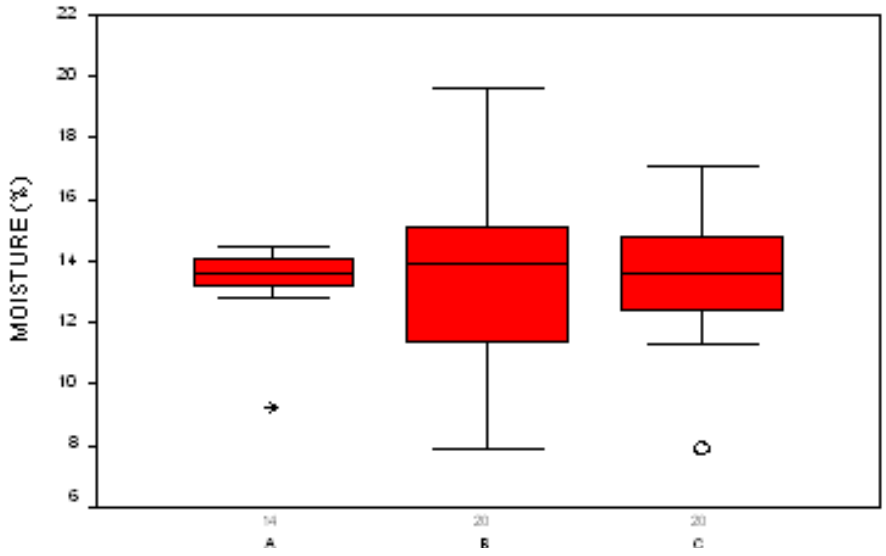
The ash content of Dharwad Peda varied in the range of 2.44% to 3.26% with an average value of 2.8±0.32. Similarly there was not much variation in the ash content of other varieties of peda. The range was 1.8% to 3.42% with a mean value of 2.89±0.37%. Similar variation has been observed in the ash content of the samples of peda sold as 'Dharwad Peda', the range being 1.48% to 3.42% (Figure 17). There was considerable overlapping in the ash content of Dharwad Peda and other varieties of peda (Figure 18). Statistical analysis also showed that there was no significant difference between the ash contents of Dharwad Peda and other varieties of peda.

Several workers have reported ash content of samples of peda from different regions of the country. Vijayakhader and Patel (1983) reported a lower value of 1.8% in peda collected from Anand. Garg and Mandokhot (1987) reported 2.0% in samples of peda sold in Hissar and Hansi. Reddy and Rajorhia (1992) reviewed the reported ash contents of peda from different regions of the country. The range was 1.4% to 3.4%. Ray *et al*., (2002) reported 2.37± 0.08%



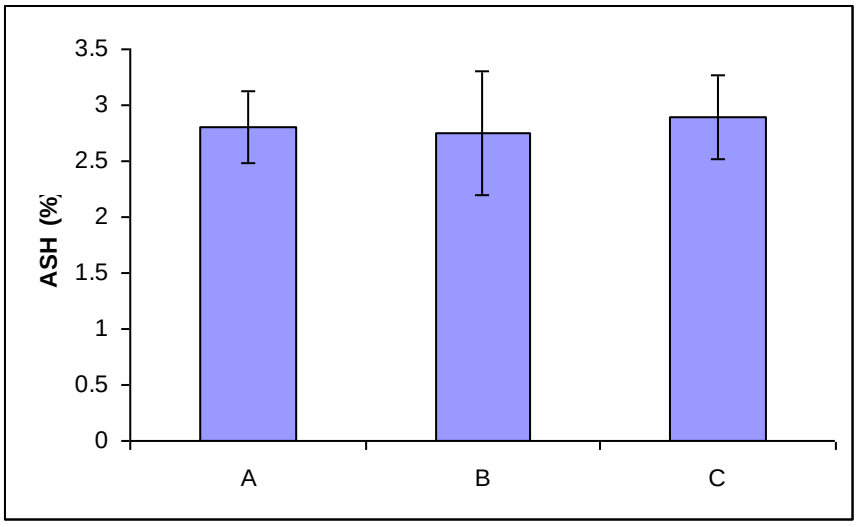
A – Dharwad Peda produced in Dharwad, B – 'Dharwad Peda' produced elsewhere
C – Other varieties of peda

Figure 15: Mean and standard deviation of moisture content of peda



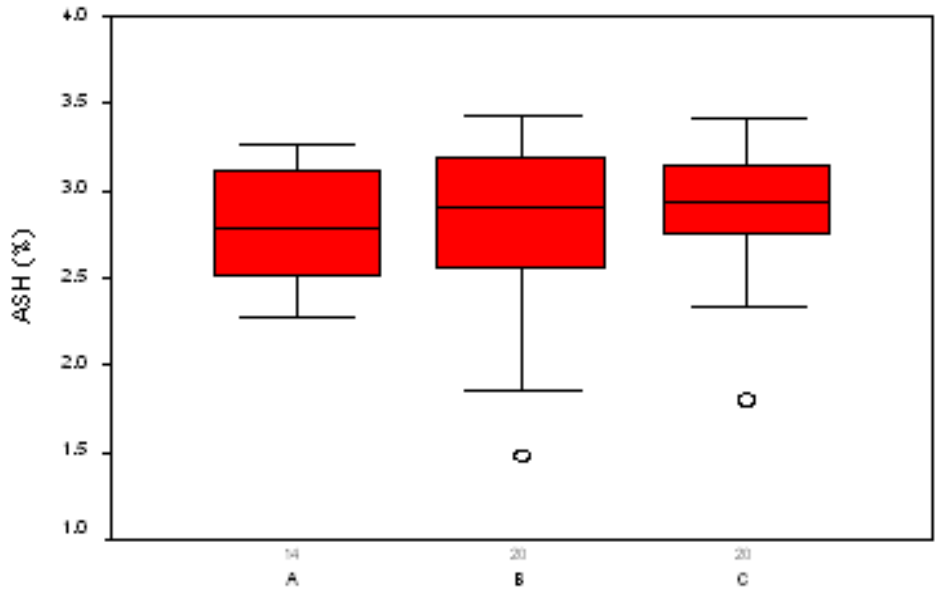
A – Dharwad Peda produced in Dharwad, B – 'Dharwad Peda' produced elsewhere
C – Other varieties of peda

Figure 16: Box plots of moisture content of peda



A – Dharwad Peda produced in Dharwad, B – 'Dharwad Peda' produced elsewhere
C – Other varieties of peda

Figure 17: Mean and standard deviation of ash content of peda



A – Dharwad Peda produced in Dharwad, B – 'Dharwad Peda' produced elsewhere
C – Other varieties of peda

Figure 18: Box plots of ash content of peda

ash for samples of peda sold in Kolkata. Patel *et al*. (2006) compared ash content of samples of peda produced by traditional technology and mechanized method in Gujarat city. They found an ash content of 2.0% and 2.8% for peda manufactured by traditional technology and mechanized method respectively .On the other hand, Kumar *et al*. (1997) reported a higher value (3.8%) for kesar peda produced in Sugam Dairy, Baroda.

Since the ash content of milk is fairly constant, much variation in its level in peda was not to be expected. Ash level would be low in samples in which the proportion of sugar was very high resulting in proportionate reduction of milk solids. Similarly high levels of ash in the product could arise from neutralization of the milk used for khoa making or use of alkaline salts during desiccation to obtain higher browning (Patton, 1952; Spark, 1969; Fox, 1981; Ashoor and Zent, 1984). Since samples of traditional Dharwad Peda did not give high levels of ash, use of such additives during its production may be ruled out. Further confirmation of this would come from a study of acidity/pH of the samples.

4.5.7 Acidity / pH

The mean acidity of Dharwad Peda samples was 0.63± 0.11% lactic acid. The samples grouped under other varieties had a corresponding acidity level of 0.40± 0.09% lactic acid. Thus Dharwad peda samples were significantly more acidic than the other varieties. The mean acidity levels of 'Dharwad Peda' produced elsewhere was 0.84±0.25.

The acidity of samples noted in this study, especially those Dharwad Peda was higher than that by some other workers. Ghodekar *et al*. (1974) and Patel and Gandhi (1980) reported respectively 0.2% and 0.18% acidity in peda samples. Patel *et al.* (2006) later found 0.4% acidity in their study. However, Ray *et al*. (2002) had earlier reported a much higher value of 0.74%.

The mean pH value of Dharwad Peda in the present study was 5.4 where as the corresponding figure for other varieties was 5.9. These values are lower when compared to the values of 6.35 and 6.8 reported by Garg and Mandokhot (1987) and Patel *et al*. (2006) respectively.

The markedly higher acidity and lower pH of Dharwad Peda could have been the result of severe or prolonged heat treatment that the product had undergone during processing. It is known that severe and prolonged heat processing results in break down of carbohydrates and production of brown pigments and formation of organic acids (Webb and Johnson, 1965).

There was no significant difference in the free fatty acid content of Dharwad Peda and other varieties. The free fatty acid contents, expressed as oleic acid/100g fat was 0.2±0.02% in Dharwad Peda and 0.23±0.09% in other varieties.

5.0 SUMMARY AND CONCLUSION

Dharwad Peda is claimed to be a distinct variety of peda produced with expertise developed in the Dharwad region of Karnataka. The uniqueness of the product was ascertained through comparison of its external features, rheological properties and chemical composition with those of other varieties of peda collected from the market.

Samples of Dharwad Peda collected from Dharwad had typical natural brown colour with a coating of powdered sugar on their surface. The samples had a soft but firm body and the texture was granular. Samples of peda sold as 'Dharwad Peda' but produced outside Dharwad varied widely in colour, appearance, body and texture and scored lower in organoleptic evaluation. Some of the manufactures had tried to imitate traditional Dharwad Peda by adding colour to their products. Other varieties of peda had natural whitish yellow colour but some had added colours. They had softer body.

Traditional Dharwad Peda had distinguishing brown colour and characteristic cooked and caramelized flavour produced through browning reactions during its production. Colour and flavour characteristics of other varieties of peda appeared to depend mostly on the additives used.

Rheological properties of Dharwad Peda as measured by TA-XT plus textural analyser showed that the traditional product was distinct from other varieties of peda collected from the market. Mean value of hardness of Dharwad Peda was 15.22 N as against 8.92 N for other varieties. Different brands of the traditional product had not only higher hardness but also more uniformity than samples of the other varieties or 'Dharwad Peda' produced outside Dharwad. Dharwad Peda showed more gumminess (2.45 $\pm$ 0.42N) than other varieties (1.26 $\pm$ 1.04 N) of peda. Springiness was also higher in traditional Dharwad Peda (0.22 $\pm$ 0.04) but 'Dharwad Peda' produced outside Dharwad had springiness (0.16 $\pm$ 0.03) similar of that of other varieties of peda (0.18 $\pm$ 0.048). Another significant difference of Dharwad Peda in rheological property was with respect

to its chewiness. The traditional product had a mean chewiness value of 0.55 ± 0.16 N.mm which was about 2-3 times the corresponding value for other varieties. Thus, from the rheological analysis it could be concluded that traditional peda had distinctly higher hardness, gumminess, and chewiness than other varieties of peda.

Chemical analysis of the peda samples revealed only small differences in the levels of the major ingredients of the three groups – traditional Dharwad Peda, 'Dharwad Peda' produced elsewhere and other varieties. The fat content of Dharwad peda varied in a comparatively narrow range of 12.0 to 16.4% with an average content of 14.21%. a wider range of 9.2-21.0% fat with a mean value of 16.74% was noted in other varieties of peda. The average content of fat in 'Dharwad Peda' samples produced outside Dharwad was 15.37% and the range was 9.20 – 19.00%.

The protein content of Dharwad Peda produced in Dharwad was found to be in the range of 10.5 – 16.53% with an average value of 14.17%. The range of protein content of other varieties and 'Dharwad Peda' produced elsewhere were 11.61 – 19.47% and 8.0 – 16.53% respectively. Corresponding mean values were 15.23 and 13.53%.

Lactose content of Dharwad Peda ranged between 15.38% and 19.43% with an average value of 17.37%. In 'Dharwad Peda' samples from outside Dharwad, the content ranged from 12.27 to 21.90%. A wider range of 12.16 – 22.19% was noticed in samples of other varieties. The mean levels of lactose in the samples of the three groups did not differ significantly.

Sucrose level was higher in Dharwad Peda samples. It ranged between 34.01% and 48.4% with an average value of 38.97%. In other varieties of peda, the range was wider, between 27.65 and 57.9% and the average content was 34.38%. Samples of 'Dharwad Peda' produced elsewhere too showed wide variation in their sucrose content – 30.34 to 53.02%. The mean level of sucrose in samples of this group was 37.95%.

The average level of moisture in Dharwad Peda was 13.33%; the range was between 9.2 to 14.48%. Though the average level of moisture in samples of

the three groups did not differ, the individual samples in other groups showed wider variation.

As in the case of moisture, ash contents of the samples of the three groups were similar. The average content of ash in Dharwad Peda was 2.8% with a range of 2.44 – 3.26%.

Dharwad Peda had significantly higher acidity (0.63% lactic acid) and lower pH (5.4) than samples of other varieties. This could have been the results of severe or prolonged heat treatment that the product had undergone during processing. It is known that such heat processing results in breakdown of carbohydrates and production of organic acids along with brown pigments.

Statistical analysis showed small but significant differences in the composition of traditional Dharwad Peda from that of other varieties collected for the study. Fat and protein contents were found to be less in Dharwad Peda but the level of sucrose was more. However, considering the wide range of values reported for these constituents of peda from different regions, the small difference in composition noted in this study could not be taken as a distinguishing factor.

It can be concluded that it is the processing conditions that give Dharwad Peda its distinguishing colour, flavour and texture characteristics and not any major difference in its chemical composition.

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APPENDIX I

DAIRY CHEMISTRY SECTION

Name of the Judge: Date:
Time: Batch no.

---------- is/are served to you for organoleptic evaluation. Please judge the product on 9-point hedonic scale. Please write your valuable comments below in the remarks column.

	I	**II**	**III**	**IV**	**V**	**VI**
1. Appearance & Color						
2. Flavor						
3. Body & Texture						
4. Overall Acceptance						

Scale

9. Like extremely
8. Like very much
7. Like moderately
6. Like slightly
5. Neither like nor dislike
4. Dislike slightly
3. Dislike moderately
2. Dislike very much
1. Dislike extremely

Signature **Remarks**