Traditional Indian Foods: Physico-Chemical Aspects Dr. J. S. Pai,

Like our culture, Indians have a very long tradition of some typical foods, developed in Indian subcontinent and now eaten all over the world. There is a typical cooking style. Indians like to eat rice, chapatti or roti, with curried vegetables and meat or fish, dals, with some accompaniment of pickles, papads, chutneys, raita etc. Indians love their sweets including peda, burfi, rasogolla, sandesh, gulab jamun, jalebi, petha, carrot or wheat halwa, shrikhand, basundi, chikki, Mysore pak and a long list of a variety of sweets. They also love to eat breakfast, snack and savoury (namkeen) items like samosa, vada, idli, dosa, dhokla, pakoda, sev, bhujia, ganthia, chivda, farsan, chakli, bhelpuri etc. The variety in meal items, breakfast items, snacks, sweets, etc. is just mind boggling and a short lecture or even a seminar would not do justice to the intricacies and innovative practices followed in preparing these. More recently, there has been a further advancement I will just try to give a small glimpse into the physico-chemical aspects involved in their preparation.

The products were prepared in order to either preserve the perishable foods. Examples would be milk is converted to khoa which can last for a much longer period. Fruits and vegetables are converted to morabba, fruit leather, candy or pickles.

Another reason is to make them palatable, edible and tasty. Cereals and pulses are consumed by cooking them. Spices were added to improve their palatability but preparing a large number of savoury products improved their taste and flavour. However, again the cooked grains and pulses had limited shelf life, so in order to preserve them either moisture had to be removed. This may be done by drying but even a more tasty alternative is frying them. There is also another way of preserving them and that is by adding sugar or jaggery to them to make sweets out of them. Laddoo, Mysore pak, carrot halwa, Bombay halwa, are some examples and the both frying and sugar are used in jalebi.

Some of the products are made in order to make them more nutritious, while enjoyable. Cereals and pulses when mixed, give a better amino acid profile, which is seen in such products like idli, dosa, dhokla etc. which are also fermented so their vitamin contents are also enhanced. Even in products like chivda, farsan, certain chikkis etc. this improvement is seen.

There are many other reasons such as regional preferences and availability of certain raw materials that would also influence the types available. North with more milk production and consumption would have sweets based on milk, and East with preference for cow's milk has a lot of chhana based products prepared from cow's milk. South has preferences for grain and pulse based sweets, but this is now slowly disappearing. The regional specialities are now getting consumed everywhere.

There are also some products which have religious significance, example being modak preferred by Lord Ganesh. Some of the sweets have some festival connotations and some foods have acquired fasting food status.

Let us look at some examples from some typical group of products to understand the chemical aspects involved in the preparation of these products, which have the physical and sensory relevance such as colour, flavour, texture, appearance etc. for which these products are consumed.

Milk Products:

Although cow's milk is mostly consumed world over, Indians consume buffalo milk much more than cow's. Although goat milk consumption is also significant it is quite low compared to buffalo and cow. There are inherent differences in chemical and physical properties of the two milks as seen below.

Composition of Cow & Buffalo Milk

Constituent (%)	Cow Milk	Buffalo Milk
Water	86.50	83.18
Fat	4.39	6.71
Protein	3.30	4.52
Lactose	4.44	4.45
SNF	9.11	10.11
Total solids	13.50	16.82

These are only the average values. There are many differences that will be seen within these which may be due to breed, time & stage of milking, lactation period, season, feed, nutritional level, environmental conditions, health, age, exercise, medication and hormonal treatments etc.

The intrinsic quality of chemical constituents through differences in species/breeds makes their milk eminently suitable for certain specialised products. For example, qualities such as high total solids content, superior whiteness and viscosity render buffalo milk suitable for making khoa, peda, burfi, dahi, paneer, kheer, payasam, malai, kulfi, ghee and other traditional products. Cow milk yields a soft coagulum, making it suitable for preparation of chhana and its products such as sandesh, rasogolla, chumchum and rasmalai.

In cow milk, carotene is the major pigment and it is derived from feed. It gives cow milk a pale yellow appearance. However, buffalo has the ability to convert carotene into vitamin A before passing it into milk and so it appears white. Therefore when you want whiter base such as khoa, then buffalo milk is preferred. From this one can prepare coloured sweets by adding a variety of colours.

Buffalo milk also has more protein and fat. The coagulable proteins, caseins are much more in buffalo milk, so when milk is coagulated by heat and/acid, there is firmer and denser coagulum produced which is suitable for products like paneer, peda, burfi etc. Cow's milk produces softer coagulum and gives a springy texture, which is more suitable for products like rasogolla, sandesh and rasmalai.

Traditional milk sweets

Indian mithais have been developed to preserve the nutritional goodness of milk and to extend its shelf life under high ambient temperature. Sweets are mainly prepared from three intermediate product bases: khoa (partially heat-desiccated milk), chhana (coagulated milk after draining of whey) and chakka (concentrated curd). Ghee and makkhan are traditionally prepared to conserve milk fat in areas where production of liquid milk is surplus. Much of the processing of sweets is done on a small-scale by the halwai.

Khoa is a major intermediate product base for a variety of sweets. It is obtained by rapidly evaporating milk in shallow pans to a total solids content of about 70%. The product could be preserved for several days and is also used as a base for different kinds of sweets like peda, burfi, gulab jamun, etc. Another important base is chhana. It is obtained by acid coagulation of hot milk and draining out the whey. This product is used as an ingredient in different kinds of sweets, especially in the eastern region of India. Chhana based sweets are popularly called Bengali sweets. The third major intermediate base is chakka, popular in western India. It is a fermented product obtained from dahi (curd) and is used in a variety of Gujarati and Maharashtrian desserts. Traditional dairy products in India:

Desiccated Milk-based Products: Khoa/Mawa, Gulabjamun, Kalajamun, Lalmohan, Burfi, Kalakand, Milk cake, Peda, Rabri, Khurchan, Basundi and Kulfi

For these products the starting material is khoa or mawa, which is prepared by concentrating milk to a pasty consistency by constant stirring. Thus the only constituent that is reduced is water with almost all others remaining with the product. This product is very pliable and with addition of sugar and some other minor ingredients for flavour and colour a variety of different products are prepared.

Three types of khoa are available in market, dhap, pindi and danedar. The first two have the difference only in concentration as pindi has more solids. Danedar is prepared with some acid being added towards latter part of concentration, which gives the granular texture preferred in certain types of sweets.

Types of Khoa and Products

Type	TS (%)	Fat (%)	Products
Dhap	56-63	20-23	Gulab jamun
Pindi	67-69	21-26	Burfi, Peda
Danedar	60-65	20-25	Kalakand, Milk cake

Heat-Acid Coagulated Products: Paneer, Chhana, Rasogolla, Rasomalai, Rajbhog, Khirmohan, Sandesh, Pantua, Chhana-Murki and Chamcham

The difference between paneer and chhana is traditionally the former is prepared from buffalo milk and the latter from cow's milk. Since buffalo milk has more fat and protein as well as due to the compactness and firmness of the coagulum paneer is usually much firmer or tougher than chhana, which is much softer when prepared from cow's milk. Legally there is hardly any distinction. Both are prepared by heat coagulation after lowering the pH by limejuice or acidulants like citric or lactic acid. This process leaves out whey, which contains lactose. Since the product contains very little lactose and contains mostly protein and fat, it is very spongy compared to khoa, which contains good amount of lactose.

Thus the products prepared from chhana like rasagolla, rasomalai, sandesh, etc. are quite elastic and distinctly different from peda, burfi etc.

Cultured/Fermented Products: Dahi, Mishti Doi, Shrikhand, Lassi, Mattha/Chhach/ Chhas, Kadhi, Raita, and Dahi vada

When milk is allowed to ferment, lactose (milk sugar) gets converted to lactic acid and pH drops. This fermentation is carried out by lactic acid bacteria and one gets products like curd (dahi), yoghurt etc. The difference between the Indian curd and western yoghurt is that curd fermentation uses natural flora and commonly one gets less acidity, while yoghurt fermentation uses pure starter culture consisting of mixed lactic acid bacteria, which are rapid fermenters of lactose and one gets higher acidity. Examples of cultures for curd are Lactococcus lactis variants, Lactococcus diacetylactis, Lactococcus cremoris etc. and for yoghurt are Lactobacillus dekbruckii and Streptococcus thermophilus. Bigger producers are now using standard cultures for curd manufacture. The curd is usually more flavourful than yoghurt, the final product may contain some flavourants. Curd flavour will also depend on the type of microorganisms in the flora used for fermentation and thus may vary.

Whey is then drained using cloth (modern processes use basket centrifuge) which removes most of the unfermented lactose. Sweets like shrikhand, mishti doi etc. are prepared by adding sweeteners like sugar and jaggery along with flavourants and colours.

Sweeteners used in Indian sweets

Sugars used in Indian sweets have many functions including bulking agent, preservative, texturiser, humectant, dispersing agent, stabiliser, fermentation substrate, flavour carrier, browning agent and decorative agent.

Sugar cane is the major source of sweeteners from which jaggery, raw or bura sugar, khandsari and refined sugar are prepared. These have different degree of refinement, during which slowly the non-crystallisable materials are removed thus from brown to white or colourless products are obtained. Jaggery contains varying amounts of glucose+fructose to sucrose depending of the extent of hydrolysis during heat treatment to remove water. Removal of scum and use of sulphites gives lighter colour.

Jaggery is used in many sweets thus giving them its characteristic flavour and colour. Higher amount of mono-saccharides give textural attributes to products making them softer or more chewy. When these are removed during refining, the products then become harder and more brittle. A typical example is chikki, mostly prepared from ingredients like nuts, cereals, oil seeds etc. Groundnut, cashew, rajgeera (amaranth seeds), til (sesame) etc. are quite popular. When jaggery with a lot of mono-saccharides is used the chikki is softer and more chewy. The texture could be adjusted using some sucrose, making it harder. Popular cashew chikkis normally use sucrose and/or glucose, since their flavour is neutral unlike jaggery, so you get more cashew flavour.

Jaggery is being used to lesser extent as even cottage scale sweet manufacturers have started using sucrose (common refined sugar). Jaggery has some of the micronutrients including iron and calcium. Jaggery is also produced from other sources like date, palm etc.

Sugars have other properties like preservative. Some of the fruits are preserved in the form of preserves (morabba) and jams. Of these, amla and mango are more popular. Sugars also important browning agent. Jaggery has a natural brown colour, but even sucrose when heated caramelises to give golden brown colour. In milk sweets, there is an additional opportunity for sugars to react with proteins to give brown colour. This is seen in some versions of peda especially the Dharwad Peda, which is brown and coated further with sugar crystals. Gulab jamun is fried and gets brown due to reaction between protein and lactose as sucrose is yet to be added in the form of syrup. Bulking properties of sugar became more important when efforts were on to formulate sugarless sweets using artificial sweeteners. Sugars normally forms a very significant portion of Indian sweets (which are sweeter that western sweets), and provide both the bulk and texture.

Chapatti and Roti

Wheat flour has been used to make a large number of staple products like chapatti, roti, phulka, paratha, nan, bhakri, kulcha, bhatura, puri and a large number of variants in many of these. Whole wheat flour (atta) is used in most products but in some like nan, bhatura etc. refined flour may be used, in bhakri jowar & bajra flours may be used, in roti corn flour may be used. Most of the products may be roasted or baked but bhatura and puri are fried. Although all may be classified as unleavened breads, some are fermented e.g. nan uses fermentation to make it light.

Chapatti is made typically with whole wheat flour with water, oil and salt to make a soft dough. It is rolled, folded and rolled again after applying oil before folding. Sometimes dough is allowed kept aside before rolling to get soft chapattis. Gluten formation may be making them pliable and soft. The rolled sheets are then roasted or pan fried.

Roti is a thicker version of chapatti. Addition of maize flour or bajra flour to wheat flour will give makeki or bajreki roti. Usually rotis are not as soft as chapattis and sometimes they are very hard. Rotis are mostly made in north India and chapattis in western parts with some south families making them.

Advent of refined flour, maida has allowed some of the variations, especially the nan. Fermentation with yeast gives fluffy dough which makes a light nan. Curd is originally used as a source of fermenting microbes but now yeast is used in addition to ensure rapid fermentation. Bhatura also uses refined flour and fermentation. Puri is made with whole wheat flour and unfermented unlike bhatura although both are finally fried before consumption. Use of refined flour and fermentation gives added softness and fluffiness to the product. Since refined flour lacks bran present in whole wheat flour, there is nutritional compromise.

Papad

This is a typical Indian product now becoming popular world over. Made commonly from black gram, but now a large number of ingredients are being used from a variety of pulses, rice, potato, jackfruit, etc. together with spices, salt, oil, leavening agent etc. The dough made of these must have a proper consistency so it could be rolled thin circular sheet. This is then dried to stabilise under ambient conditions. These are eaten after frying or roasting, which drives the last traces of moisture and makes them very crisp.

The dough consistency with proper amount of water added to ingredients, rolling with use of oil to prevent sticking, proper rolling to ensure proper distribution of stresses created in the dough so during drying they do not go out of shape and after frying they remain crisp and not too hard or limp. These were some of the problems the machinery developers had to solve for large scale production. But now they have not only the original papads but a huge range of papads with different flavours, colours, sizes and shapes.

Basic papads are made from black gram, which has proper amount of protein and starch together with other polysaccharides to give good stiff dough that could be rolled into fairly thin sheets with the help of oil. With proper amount of water, the dough does not disintegrate. The moment other ingredients like rice flour is added, protein content goes down and starch also is less pliable as it has more amylose. This is where ingenious combination of other legume flours becomes useful.

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