Cibtech Journal of Bio-Protocols ISSN: 2319–3840 (Online)
An Online International Journal Available at http://www.cibtech.org/cjbp.htm
2012 Vol. 1 (2) September- December, pp.32-44/Aswal et al.
Review Article

YOGHURT: PREPARATION, CHARACTERISTICS AND RECENT ADVANCEMENTS

Priyanka Aswal, Anubha Shukla and *Siddharth Priyadarshi
School of Biotechnology, Gautam Buddha University, Yammuna Expressway, Greater Noida (U.P)
**Author for Correspondence*

ABSTRACT
Yoghurt is a fermented dairy product, having several health benefits. Yoghurt starter culture consists of a blend of *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp *Bulgaricus*. Yoghurt is mainly of two types i.e. set yoghurt and stirred yoghurt. Yoghurt properties can be enhanced by the addition or treatment with various additives. Alternative methods to improve quality of low-fat yoghurt become an area of considerable research interest. Lactic acid can be produced by the yoghurt. Yoghurts that have past their 'best before' date constitute a waste that has to be environmentally treated. It can be used as a source for lactic acid production by *Lactobacillus casei* . Yoghurt can be supplemented with various useful ingredients. Addition of herbs or their active components like oils could be an effective strategy to improve functionality of milk and milk products with respect to the health benefits, food safety and biopreservation. Recent developments in this regard have been thoroughly discussed.

***Key Words*:** *Rheology, pH, Sensory attributes, Syneresis, Microbiology and Recent advancements*.

INTRODUCTION
Yoghurt is a fermented milk product obtained from the milk or the milk products by the lactic acid fermentation through the action of *Streptococcus salivarius* subsp. thermophilus, *Lactobacillus delbrueckii* subsp. bulgaricus (FAO/WHO, 1977). When a sufficient quantity of lactic acid is produced then the milk coagulates and this coagulated milk is called yoghurt. The probiotic yoghurt, having probiotic effect is a fermented milk product with adjuvant microorganisms. There is numerous advantages of consuming fermented dairy products containing probiotic bacteria. A high population of probiotic organisms in the colon contributes to good intestinal health. Consequently consumption of products such as yoghurt containing viable probiotic organisms adds benefit to human gut health. Moreover, yoghurt supplies good quality proteins, also an excellent source of calcium, phosphorus, potassium and contains significant quantities of general vitamins. Yoghurt could be used for feeding, owing to its higher Ca/Na ratio (Demott, 1985). Yoghurts vary in appearance, flavor and ingredients. The quality and composition of yoghurt of applied bacterial cultures affects the quality of the yoghurt obtained as the result of the milk fermentation processes. There is a symbiotic relationship between the two species of bacteriai. E *Lactobacillus bulgaricus* and *Streptococcus thermophilus*that's why there is more rapid acid development than in the single strain culture (Rasic *et al.*, 1978; Tamime *et al.*, 1980). Various combinations of starter cultures are selected during manufacturing of yoghurt to achieve desirable characteristics of product and also to provide the consumers with a wide choice of therapeutic benefits. Depending on its activity, manufacturer usually adds 2-4 % yoghurt starter culture. Now a days, there has been increasing trends to fortify the dairy product with fruits (natural fruit juice, pulp, dry fruits) (Desai *et al.*, 1994; Ghadge *et al.*, 2008). Aesthetic value of new product can be increased by using fruit juice as a functional pigment in fermented milks with array of colors and flavor properties. Coisson *et al.*, (2005) used Euterpeoleracea juice as functional pigment for yoghurt, which is dark purple in color having high anthocynin and phenolic content.
Yoghurt is a functional food. The functional food includes probiotics, prebiotics and synbiotics. Probiotics can be defined as "live microbial feed supplements that beneficially affect the host animal by improving its intestinal microbial balance" (Champagne *et al.*, 2005). Prebiotics as "non-digestible food ingredient that beneficially affects the host by selectively stimulating the growth and/or activity of one or

a limited number of bacteria in the colon". Synbiotic is a combination of probiotics and prebiotics that "beneficially affects the host by improving the survival and the implantation of live microbial dietary supplements in the gastro-intestinaltract by selectively stimulating the growth and/or by activating the metabolism of one or a limited number of health promoting bacteria" (DiRienzo *et al.*, 2000).

Production of Different Types of Yoghurt

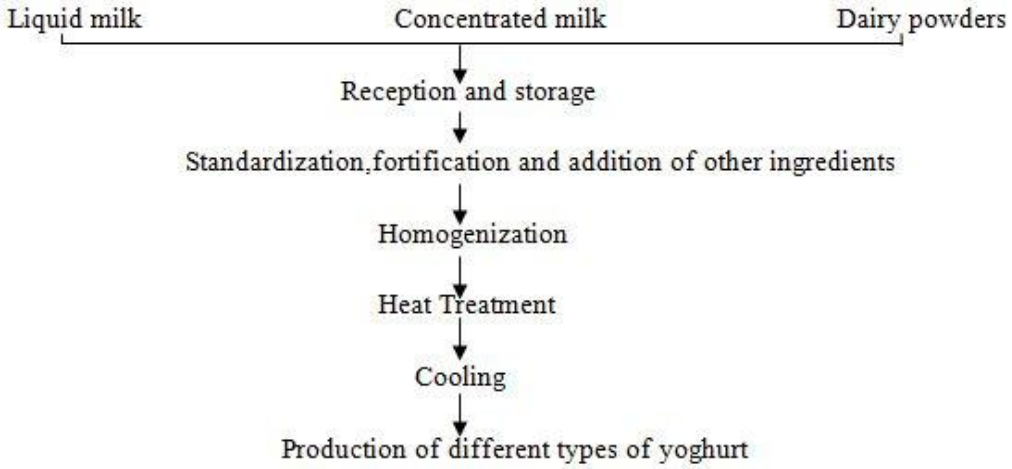

Figure 1: Processing of Yoghurt

Processing of Set and Stirred Yoghurt (W.J Lee and J.A Lucey, 2010)

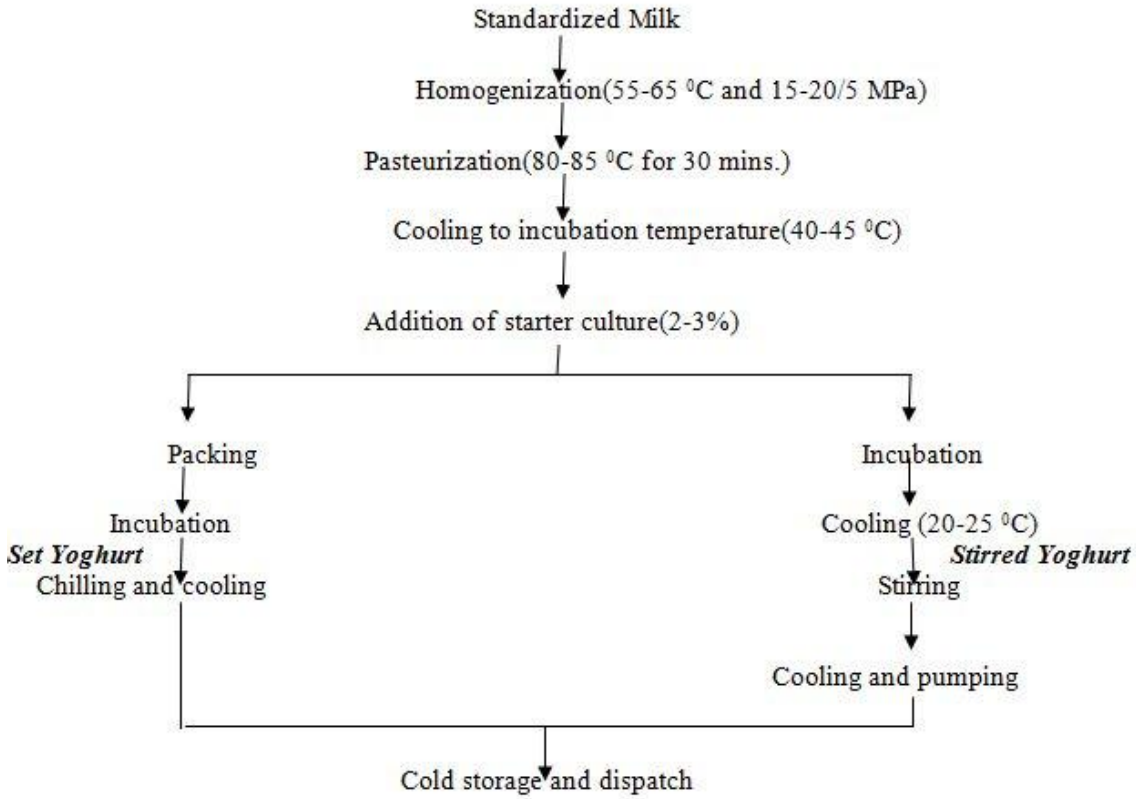

Figure 2: Processing of Set and Stirred Yoghurt

Characteristics of the coagulum may be influenced by the processing conditions. Characterization of milk homogenization is done by breaking of the milk fat globules into smaller sizes. This improves the consistency and viscosity mainly because it prevents the rise of milk fat to the surface in the incubation tanks or in the retail container (it reduces synergesis and the tendency of the small fat globules to coalesce, because fat becomes coated with casein). The protein network has interstitial spaces containing the liquid phase and void spaces in which starter culture is present. After incubation, the coagulum of stirred yoghurt is broken up mechanically before cooling and packaging, thus inducing considerable changes in the rheological properties (Tamime *et al.*, 1980).

Nutritional Information of Yoghurt

Table 1: Nutritional facts of Yoghurt

Components	**Value (per 100g)**
Energy	257KJ
Carbohydrates	4.7g
Fat	3.3g
Protein	3.5g
Vitamin A equiv.	27 µg (3%)
Riboflavin (vit. B2)	0.14 mg (12%)
Calcium	

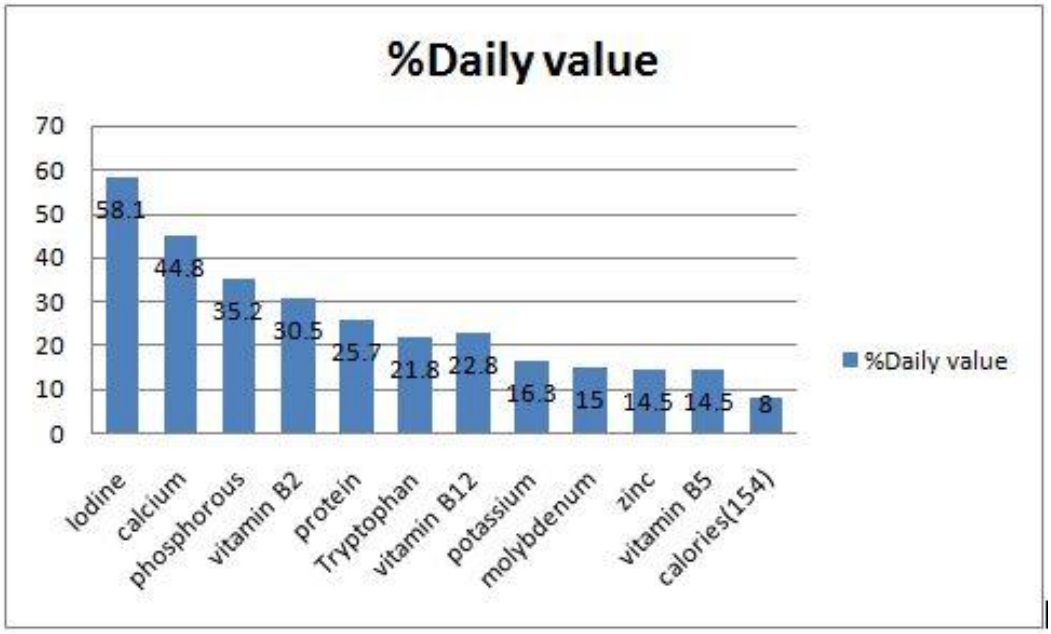

Figure 3: Nutrients in yoghurt per cup (245.00gms) (www.whfoods.com)

The word "yoghurt" is derived from Turkish "jugurt", used to describe any fermented food with an acidic taste (Younus *et al.*, 2002). Historically, yoghurt was made by fermenting milk with indigenous microorganisms. Yoghurt having high nutritional and therapeutic properties is being highly consumed and produced (Karagul *et al.*, 2004). Yoghurt is stored at 2- 4ºC throughout the distribution chain for avoiding risk of spoilage from yeasts (Tamime *et al.*, 2000) and also for preventing further activity by starter culture.

Different Types of Yoghurts

Yoghurt is typically classified into the following groups

Set Yoghurt

This type of yoghurt is incubated and cooled in the final package and is characterized by a firm jelly like texture.

Stirred Yoghurt

This type of yoghurt is incubated in a tank and the final coagulum is "broken" by stirring before cooling and packing. The texture of stirred yoghurt will be less firm than a set yoghurt somewhat like a very thick cream. A little reformation of coagulum will occur after packaging.

Drinking Yoghurt

It also has the coagulum "broken" prior to cooling. In drinking yoghurt the agitation used to "break" the coagulum is severe.Very little reformation of coagulum may occur.

Frozen Yoghurt

Frozen yoghurt is inoculated and incubated in the same manner as stirred yoghurt. However cooling is achieved by pumping through a Whipper / chiller / freezer in a fashion similar to ice-cream. The texture of the finished product is mainly influenced by the whipper/ freezer and the size and distribution of the ice crystals produced.

Concentrated Yoghurt

This type of yoghurt is inoculated and fermented in the same manner as stirred yoghurt. Following the "breaking" of the coagulum the yoghurt is concentrated by boiling off some of the water, this is often done under vacuum to reduce the temperature required. Heating of low pH yoghurt can often lead to protein being totally denatured and producing rough and gritty textures. This is often called strained yoghurt due to the fact that the liquid that is released from the coagulum upon heating used to be "strained" off in a manner similar to making soft cheese.

Flavoured Yoghurt

The flavours are usually added at or just prior to filling into pots. Common additives are fruit or berries, usually as a puree or as whole fruit in syrup. These additives often have as much as 50% sugar in them, however with the trend towards healthy eating gaining momentum, many manufacturers offer a low sugar and low fat version of their products. Low or no sugar yoghurts are often sweetened with saccharin or more commonly aspartame.

Classification of Yoghurt

There are different types of yoghurt produced worldwide. However a Particular yoghurt may be subdivided into different groups based on the following aspects

Table 2: Classification of Yoghurt

Sl. No.	Basis of Classification	Different Groups of Yoghurt
1.	Chemical standards(Fat)	Full, skimmed/medium or skimmed/low fat
2.	Physical nature of product	Set, stirred or fluid/drinking; the latter is considered Stirred yoghurt of low viscosity
3.	Flavors	Plain/natural, fruit or flavored;
4.	Post fermentation processing	Enzyme hydrolysis, vitamin fortification, vegetable oils, heat treatment

Set yoghurt is fermented in a retail container, filled after milk inoculation and is incubated in an incubation room at a suitable temperature normally 40- 43°C for approximately 2:30 to 4 hrs (Desai *et al.*, 1994). Stirred yoghurt is a non-Newtonian fluid, obtained by promoting the growth of *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus salivarius* subsp. *thermophilus* at a mild temperature (between 40°C and 43°C) until a desired acidity level is reached. In stirred yoghurt, milk is inoculated and

incubated in a fermentation tank, the yoghurt gel being broken up during the stirring, cooling and packaging stages. Due to several factors there may be variations in the rheological properties of stirred yoghurt.These can be of a physical nature such as those related with total solid content, milk composition and type of starter culture or processing conditions-related such as homogenization, thermal pre-treatment of the milk and post-incubation stages (including: stirring, pumping, cooling and packaging) (Tamime *et al.*, 1980).

Health Benefits of Yoghurt

Probiotic yoghurt is aimed at reducing medical conditions by restoring the beneficial microbial population in the colon, medical conditions such as constipation and diarrhea.

It is beneficial to our digestive system, especially stomach and colon. Cow's milk is preferred for preparing yoghurt as having low fat.

It provides immunity, protect us from cold, cough and strengthen body's defense mechanism.

It strengthens the collagen in the skin and is good for our skin.

It lowers the blood pressure, bad cholesterol and risk of heart attacks.

Yoghurt is a source of natural proteins; it is safer for those having problem in tolerance of lactose.

Yoghurt is rich in calcium so; it protects the bones against osteoporosis and arthritis.

It discourages vaginal infections.

It helps in cutting down calorie and thus helps in burning fat.

By daily consumption of yoghurt, disease causing bacteria are flushed out from the colon and thus help in protecting against colon cancer.

Consumption of yoghurt can shut down *Helicobaterpylori*; the bacterium responsible for most ulcers.

Microbiology of Yoghurt

Starter cultures

There is a symbiotic relationship between the two species of bacteria i.e. *Lactobacillus bulgaricus* and *Streptococcus thermophilus*that's why there is more rapid acid development than in the single strain culture (Rasic *et al.*, 1978; Tamime *et al.*, 1980).

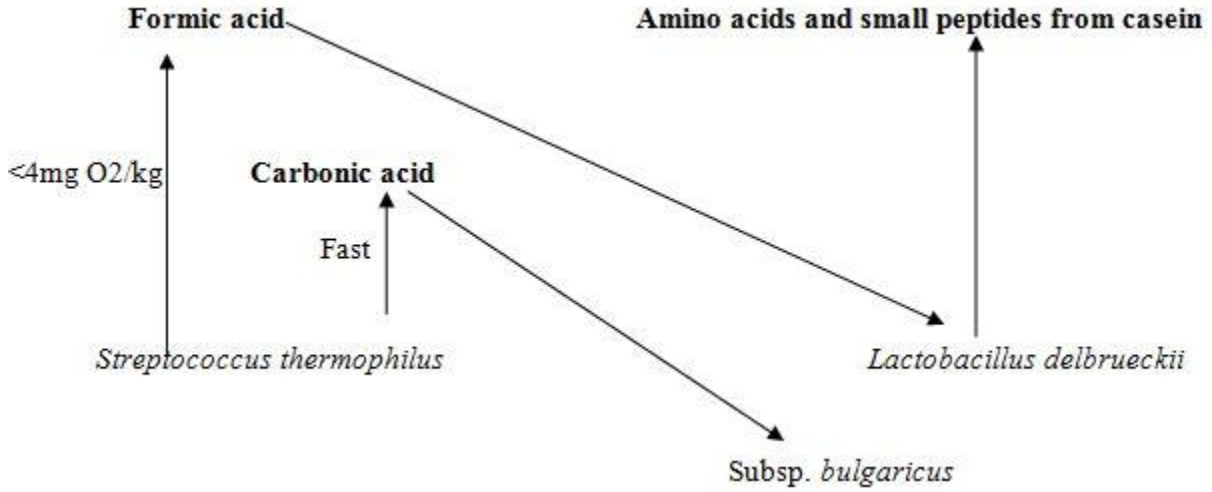

Figure 4: Symbiosis between *Streptococcus thermophilus* and *Lactobacillus delbrueckii* Subsp. *bulgaricus*

Streptococcus thermophilus produces lactic acid and small quantities of formic acid, which promotes outgrowth of *Lactobacillus delbrueckii* Subsp. Bulgaricus.On the other hand *Lactobacillus delbrueckii* Subsp. bulgaricusspecies produce aminoacids to stimulate the growth of *Streptococcus thermophilus*

Chemical composition of the milk base (total solids and fat content) have significant effects on the activity of starter cultures. Ozer and his co-worker have studied the behavior of starter cultures in

concentrated yoghurt produced by different methods. They discovered that production method and milk total solids content influenced the growth and activity of starter cultures (Ozer and Robinson, 1999).

Lactobacillus delbrueckii subsp. bulgaricus

It is a gram-positive rod shaped, filamentous, non motile, non spore forming bacteria. It requires a low pH (around 5.4 - 4.6) to grow effectively so the bacterium is regarded as aciduric or acidophilic. The bacterium has complex nutritional requirements including the inability to ferment any sugar except lactose, from which it produces lactic acid that helps to preserve yoghurt. It is often helpful to sufferers of lactose intolerance whose digestive systems lack the enzymes to break down lactose to simpler sugars. While fermenting milk, it produces acetaldehyde, which is one of the main yoghurt aroma components (www.wikipedia.com).

Streptococcus thermophilus

The genus *Streptococcus* comprises several harmful pathogenic species such as *Streptococcus pyogenes*or *Streptococcus pneumoniae,* together with a single 'Generally Recognized As Safe species'.*S. thermophilus S. thermophilus* since this bacterium is widely used for the manufacture of dairy products (Cvetan, 1998; Fox, 1993)

Lactobacillus acidophilus

Lactobacillus acidophilus shows a range of health benefits which include: providing immune support for infections and cancer, reducing occurrence of diarrhea in human, aiding in lowering cholesterol, improving the symptoms of lactose intolerance. Studies have shown that dietary supplementation with *L. acidophilus* decrease the number of colon cancer cells in a dose dependent manner (Rao, 1999). The better survival of *L. acidophilus* when added along with the starter was presumably due to the transient tolerance of the culture to hydrogen peroxide (Speck, 1976).

Bifidobacterium bifidium

Bifidobacteria are one of the most important group of intestinal organisms with regard to human health.*Bifidobacterium* spp. belongs to the dominant anaerobic flora of the colon. The main species present in human colon are *Bifidobacteriumadolescentis, B. bifidum, B. longum*subsp.*infantis, B. breve*and *B. longum* (Holzapfel, 2001). *B. bifidum* was found to be tolerant to the acidity of a model gastrointestinal tract system, with only a 20 % decrease in numbers as the pH decreased from 5.0 to 1.8 over an 80 min period (Holzapfel, 2001). Important property of probiotic bifidobacteria is acid tolerance, enabling the cells to survive gastric acidity and volatile fatty acids produced during fermentation in the intestine (Charteris, 1998). In the presence of yoghurt starter organisms the growth of bifidobacteria seems to be suppressed. Bifidobacteria have a higher resistance to acid and bile present in the gastrointestinal tract than yoghurt bacteria. The ingestion of bifidus fermented milk led to an increase in total bifidobacteria which was related to the colonic transit of the exogenous bifidobacteria (Bouhnik, 1996). In yoghurt like product, addition of probiotic cultures to the normal starters generally results in slower growth of the probiotic strains than if they were added alone in milk (Roy, 1996; Samona, 1994). These starters produce environments that inhibit the growth of not only pathogens and spoilage microorganisms but also of probiotic (Vinderola, 2002). The phenomenon could partially be related to the production of bacteriocins or other inhibitors such as lactic and other organic acids and hydrogen peroxide produced by the starter cultures (Maus, 2003; Vinderola, 2000). In addition, starter cultures grow faster, acidification occurs rapidly, and fermentation times are much shorter in their presence which resulted in reduced availability of nutrients (Shah, 2000); thus probiotic cultures do not have time to grow extensively. Many authors also reported the capacity of bifidobacteria to synthesize galacto-oligosaccharides (Hung and Lee, 2002; Lamoureux, 2002; Saxelin, 1999).

pH *of Yoghurt*

The ideal pH of the finished product of yogurt should be between 4 to 4.1. However this pH also depends on if we add fruits or flavoring agent to the yogurt. But after fermentation when the yogurt is ready to eat, the pH should be 4.The pH of yoghurt is decreased if the amount of skimmed milk powder is increased. The yogurt mixture coagulates during fermentation due to the drop in pH. The streptococci is responsible

for the initial pH drop of the yogurt mix to approximately 5.0. The lactobacillus are responsible for a further decrease to pH 4.5.

Shaker *et al* studied the effect of milk fat content on the acid development during fermentation and rheological properties of plain yoghurt. They indicated that increasing milk fat content, increased the initial pH of the samples and the rate of decreasing pH during incubation of high fat samples was lower than others (Shaker *et al*, 2000).

The Effect of* pH *on Yoghurt

Change in pH from 6.6 to 6.0

When the pH of the milk is decreased from 6.6 to 6.0 then the electrostatic repulsion decreases; as the net negative charge on the casein micelles decreases.The size of the casein micelles remains unchanged as the small amount of Colloidal calcium phosphate is solubilized at pH>6.0 .

Change in pH from 6.0 to 5.0

When the pH changes from 6.0 to 5.0 then there is decrease in electrostatic repulsion and steric stabilization occurs, which are responsible for the stability of casein micelles in the original milk. Due to the decrease in the pH, the negative charge on casein micelles decreases and the charged "hairs" of casein curls up or may shrink.

At pH 6.0

At this pH, the electrostatic repulsion between the exposed phosphoseriene residues increases, due to the increase in the rate of solubilization of colloidal calcium phosphate, which weakens the internal structure of casein micelles.

At pH 5.0

The decrease in electrostatic repulsion between casein molecules occurs at pH 5; as the net negative charge on the casein decreases. When the pH of milk becomes close to the isoelectric point (pH 4.6) then casein-casein attractions increase due to increased hydrophobic and electrostatic charge interactions (Horne, 1998). The three dimensional network is formed consisting of clusters and chains of caseins due to the acidification process (Mulvihill and Grufferty, 1995).

Rheological Property of Yoghurt

Food rheology is the study of the deformation and flow of food materials (Rao, 1999).It can be classified as a pseudoplastic material (contains a yield stress that has to be exceeded for flow to be initiated) that can be either a viscoelastic fluid (stirred yoghurt) or viscoelastic solid (set yoghurt). Viscoelastic indicates that the material is having some of the elastic properties of an ideal solid and some of the flow properties of an ideal (viscous) liquid. Yogurt exhibits time-dependent shear thinning behavior but is not a true thixotropic material, since structural breakdown due to shear is not completely reversible once the shear stops.

Physical Properties of Yoghurt

It has been found that addition of protein (i) improves water holding capacity (ii) decreases the synerisis effect and (iii) stabilizes the pH of the samples during storage (Athanasios G. Stefanakis *et al*).

The physical and sensory properties of yoghurt gels are highly influenced by the protein content and the total solids content of the yoghurt milk. A study on the effect of milk supplementation (whey, casein hydrolysate and milk protein) on the acidification and microbiological stability of fermented milks showed that acidifying activity was greatly improved with casein hydrolysate, with a reduction of the fermentation time by about 55% by comparison with the other supplementation (Oliveria *et al.*, 2001).

Despite of the above results; Abd-El Salam *et al.,* (1982) showed that total solids content had no adverse effect on starter activity or coagulation time. Increasing milk total solids from 16 to 23% had significant effect on decreasing rate of pH during fermentation (Ozer *et al.*, 1998). The incubation time for the milk at 4.6 pH was shorter than thetime of retentate (Tamime *et al.*, 1989).The Increase in milk fat content influences the growth and activity of starter cultures in samples with 2 levels of total solid (12 and 23%) (Mahdian *et al*., 2007).The chemical composition of the milk base especially total solids has the major effect on the acceptability of concentrated yoghurt. Concentrated yoghurt containing < 20% total solid

was assessed as "thin and tasteless" and that with > 25% total solid became gummy and bitter (Robinson, 1977).

Effect on Syneresis of Yoghurt

Syneresis is the extraction or expulsion of a liquid from the gel. It is the collection of whey on the surface of yogurt. Syneresis can be observed when the amount of diluents in a swollen polymer exceeds the solubility limit as the temperature changes. Syneresis is undesirable; it is the separation of the liquid phase in gels (Harwalkar *et al.,* 1983).

Major factors contributing syneresis in yoghurt includes:

Low acidity (pH >4.6) or with high acidity (pH <4.0) product.

High incubation or storage temperature.

Agitation at the time of manufacture or final product transportation.

Mixture having Low total solids content (protein and/or fat).

Milk treatment at low heat.

Excessive heat treatment of the final mix.

Milk is not homogenized prior to fermentation.

Acidification at rapid rate.

Sloping wall containers or an excessive height to width ratio.

Using rennet enzyme.

Heating of milk destined for yoghurt production is one of the processing measures, which prevents the development of syneresis in the finished product.

Effect on Sensory Attributes

Set-style yoghurt should have smooth consistency without cracks or holes, custard like, semi solid consistency without any surface whey. The heat treatment given to yoghurt made from milk at 90°C for 30 min is 'grainy', while the heat treatment given to the yoghurt made from milk at 80 or 85°C for 30 min is described as 'smooth and firm bodied'. These defects may be due to the rearrangement of the network just after the gel formation.

Textural defects may rise if excessive heat treatment is given to the milk or by addition of the whey proteins. In stirred-type yoghurt, for controlling textural defects stabilizers are being added and prevent whey separation but stabilizers are not normally added to plain, set-style yoghurt.

Immunostimulatory effects of yogurt

The preventive effects of yoghurt are investigated on the diseases such as cancer, infection, gasterointestinal disorders and asthma. It enhances the immune response, which would in turn increase resistance to immune-related diseases (Meydani *et al.,* 2000).

Recent advancements

1. Enriched probiotic yoghurt with passion fruit fiber

The passion fruit fiber is a neutral ingredient for the design of new value-added yoghurt. As compared to the control the apparent viscosity was significantly higher in fiber yoghurts co-fermented by the lactobacilli at the end of cold storage. In passion fruit fiber yoghurts the casein gel was more compact and overlaid the fiber, whilst filaments of exopolysaccharides were more frequent in control yoghurts, demonstrated by the Photomicrographs. Appearance, odor and color of the passion fruit fiber yoghurts received scores as 'good', and the intensity of the passion fruit flavor was considered weak by the sensory assessors. Thixotropy of enriched yoghurts was higher than that of their respective controls in the two cycles of shear rate (Espírito-Santo *et al.,* 2012).

2. Addition of acai pulp improves fatty acid profile and probiotic viability in yoghurt

Study has demonstrated that açai pulp addition increased monounsaturated and polyunsaturated fatty acid contents in probiotic yoghurt and enhanced the production of α-linolenic and conjugated linoleic acids during fermentation of skim milk prepared with *B. animalis* ssp. *lactis* Bl04 and B94 strains (Ana Paula do EspíritoSanto *et al.,* 2010).

3. Improving Yoghurt consistency by addition of some plant polysaccharides

Six plant polysaccharides (PS) were extracted from mature okra fruits (*Hibiscus esculents*), whole plant Jew's-mallow (*Corchorusolitorius*) and taro corm (*Arum colocasia*).The resultant yoghurt was analyzed organoleptically (appearance, body and texture and flavour) and chemically after production as well as during cold storage (0, 3, 5 and 7 days) at 5 ± 1 °C. Results showed that yoghourt with good appearance, body and texture and flavour could be produced by using PS extracted from taro at concentration 0.3%, okra at concentration 0.1% and Jew's-mallow at concentration 0.1 %(Hussein *et al.,* 2011).

4. Enriched yoghurts for lowering cholesterol

In France, a lab experiment was being conducted to evaluate the impact of health information on consumers' choices for functional food. Successive messages revealing benefits and uncertainties of consuming yoghurts with added plant sterols for reducing cholesterol were delivered (Stéphan Marette *et al.*, 2010).

Effects on Rheological Properties of Yogurt

Rheological properties of yoghurt are determined by their production conditions and composition. If there is any disturbance in the balancing of milk components then it directly impacts on the rheological properties of prepared yoghurt (Penna *et al.,* 2006).

For example-

(a). Elevation of protein content leads to increased thixotropy of the yoghurt (Lankes *et al* ,1998)

(b). Incorporation of milk fat in emulsified state results the yoghurt an increased viscoelastic properties (Houze *et al.,* 2005; Xiong *et al.,* 1991).

As there is increase in the demand for reduced fat yoghurt, efforts have been paid to improve its texture and rheology. The two conventional methods are - Elevation of non-fat total solids level of the yoghurt milk or addition of some natural or synthetic gums as stabilizers into the yoghurt milk (Guzmán-González *et al.,* 2000; Shukla *et al.,* 1986). However addition of stabilizers are restricted in some area. Enzyme-induced protein interaction in yoghurt milk is thus suggested as an applicable approach to improve the rheological properties of yoghurt products (Barbaros *et al.,* 2007).

Texture of the yoghurt was being enhanced by the addition of lactoperoxidase (LPO). Yoghurt after treatment with lactoperoxidase becomes softer and smoother in texture. Its apparent viscosity is also reduced by addition of LPO (Hirano *et al.,* 2008).

The apparent viscosity of yoghurt is also reduced by the addition of chicory inulin. It also reduces the yieldstress, complexviscosity, storage modulus and loss modulus of nonfat yoghurt (Paseephol *et al.,* 2008).

By the Addition of Horseradish Peroxidase in the skimmed milk leads to the preparation of the Set yoghurt having enhanced apparent viscosity, storage modulus and viscous modulus (Yan Wen *et al.,* 2011).

Effects on the Physico-Chemical Properties of Yoghurt Containing Probiotic Bacteria

Physiochemical properties of yoghurt is effected by the addition of tetrasodium pyrophosphate (TSPP). It reduces the soluble calcium content of the milk and increased casein bound calcium values. It has been found that 0.125%TSPP resulted in reduction in the turbidity because of micelle dispersion but at 0.15% TSPP there is increase in turbidity due to the aggregation of the casein particles. Addition of 0.05 to 0.125% TSPP to milk resulted in a reduction in the yield stress values of yoghurt compared with untreated yoghurt. High TSPP levels resulted in the increment in the pore size of gels (Ozcan *et al.,* 2008).

Different types of milk and storage time affects the physiochemical characteristics of Stirred Yoghurt

Yoghurt produced from goat's milk is characterized by its lower number of grains, mean perimeter of grains, roughness, viscosity and water holding capacity in comparison to that of the yoghurt developed using cow's milk. Yoghurt with half cow's and half goat's milk has a higher viscosity and water holding capacity than that only containing goat's milk and also has a lower number of grains, mean perimeter of grains and roughness than that only containing cow's milk (Küçükçetin *et al.,* 2011).

The physical properties of the yoghurt also changes by the treatment with the proteolytic enzymes

The yoghurt made from milk when treated with the plasmin results in lower firmness, and apparent viscosity, lower water holding capacity and protein hydration. The yoghurt made from milk when pretreated with the microbial protease has higher firmness, syneresis, and apparent viscosity, lower water holding capacity and protein hydration (Mustafa Gassem *et al.*, 1991).

Enhancement in the Nutritional quality of the yoghurt

On addition of whey protein hydrosylate [WPH] in the milk, the growth of some probiotic bacteria significantly improves, however not affecting the growth of *Lactobacillus delbrueckii* ssp. bulgaricus18, *Lactobacillus delbrueckii*ssp. bulgaricus 10442, and *Streptococcus thermophilus* (MCCOMAS *et al.*, 2006).

Theaddition of fish oil in the yoghurt resulted in the enhancement in nutritional quality of the yoghurt, helping people meeting daily nutritional requirements.

Changes in the sensory characteristic of yoghurt produced from mixture of cow's and goat's milk

The addition of goats' milk led to smaller changes in pH, a higher whiteness index, lower syneresis and a significant decrease in the firmness and consistence of the gel during storage. The physicochemical properties of yoghurts were correlated with gel microstructure. Sensory evaluation has shown that incorporating goats' milk had a significant impact on the whiteness, flavour, syneresis and lumpiness of yoghurts. In general, the higher the goats' milk content, the greater the physicochemical and sensory differences with regard to the 100% cows' milk yoghurt. Samples with half and half cows'/goats' milk were preferred by the sensory panel (Maria Vargas *et al.*, 2008).

CONCLUSION

Yoghurt is a fermented dairy product. It is having several health benefits. The intake of yoghurt can improve lactose maldigestion, it lowers bad cholesterol and is also good for skin.Yoghurt having several health benefits so, is healthier for consumption. Yoghurt supplies good quality proteins, also an excellent source of calcium, phosphorus and potassium and contains significant quantities of general vitamins.Different types of yoghurt are present and having different properties. By adding different additives or different substances in the yoghurt its property is affected like its rheological, physical, sensory, textural, physiochemical properties and its quality is enhanced.

Future Aspects

Alternative methods to improve quality of low-fat yoghurt becomes an area of considerable research interest. Lactic acid can be produced by the yoghurt. Yoghurts that have past their 'best before' date constitute a waste that has to be environmentally treated. It can be used as a source for lactic acid production by *Lactobacillus casei*. Production of yoghurt generates a residue highly supplemented with sugar and fruits syrups that can be metabolized to lactic acid. To develop a satisfying, calcium-rich food for consumption in space, white skim yoghurt, both plain and with added blueberries, was subjected to freeze-drying. Optimised freeze-drying parameters were extracted from the thermal analysis of the yoghurts, taking into account the role of the added ingredients. Rheological properties were not seriously affected by freezing, while the drying step resulted in an overall structural weakening of the reconstituted products, possibly as a consequence of the mechanical energy required for mixing with water. However, its viscoelastic properties were retained and the original strength could be recovered by modulating the amount of water. The freeze-drying process affected survival of the lactic acid bacteria, resulting in a 2–3 log population reduction. Mortality levels were reduced when sucrose and blueberries were added as ingredients.

Addition of herbs or their active components like oils could be an effective strategy to improve functionality of milk and milk products with respect to the health benefits, food safety and biopreservation. These components should improve therapeutic quality without any adverse effect on sensory and rheological attributes.

REFERENCES

Athanasios G Stefanakis, Efstratios K Stavrakakis, Konstantinos G Adamopoulos, Patroklos K Vareltzis, Athanasia M Goula. Effect of various proteins on characteristics and synerisis of tzatzik.

A Küçükçetin, M Demir, A Aşci, EM Çomak(2011). Graininess and roughness of stirred yoghurt made with goat's, cow's or a mixture of goat's and cow's milk. *Small Ruminant Research* **96**(2) 173-177.

ALB Penna, A Converti and MN de Oliveira (2006). Simultaneous effects of total solids content, milk base, heat treatment temperature and sample temperature on the rheological properties of plain stirred yoghurt. *Food Technology Biotechnology* **44** 515-518.

AP Espírito-Santo, A Lagazzo, ALOP Sousa, P Perego, A Converti, Maricê N Oliveira (2012). Rheology, spontaneous whey separation, microstructure and sensorial characteristics of probiotic yoghurts enriched with passion fruit fiber. *Food Research International*

Ana Paula do Espirito Santo, Roberta C Silva, Fabiana ASM Soares, Doudais Anjos, Luiz A Gioielli, Marice N Oliveira (2010). Acai pulp addition improves fatty acid profile and probiotic viability in yoghurt. *International dairy Journal* **20**(6) 415-422.

Bouhnik Y, Flourie B, Riottot M, Bisetti N, Gailing M F, Guibert A, Bornet F and Rambaud JC (1996). Effects of Fructo-Oligosaccharides Ingestion on Fecal Bifidobacteria and Selected Metabolic Indexes of Colon Carcinogenesis in Healthy Humans. *Nutrition and Cancer* **26** 21–29.

Coisson JD, Travaglia F, Piana G, Capasso M and Arlorio M (2005). Euterpeoleracea juice as a functional pigment for yogurt. *Food Research International* **38** 893–897.

Champagne CP and Gardener NJ (2005). Challenges in the Addition of Probiotic Cultures to Foods. *Critical Reviews in Food Science and Nutrition* **45** 61-84.

Charteris WP, Kelly PM, Morell L and Collins JK (1998). Development and Application of an in Vitro Methodology to Determine the Transit Tolerance of Potentially Probiotic *Lactobacillus* and *Bifidobacterium* Species in the Upper Human Gastrointestinal Tract. *Journal of Applied Microbiology* **84** 759–768.

Cvetan D (1998). Yogurt gaining niche in American culture. *Dairy Field* **181**(4) 23, 25–26.

Demott BJ (1985). Nutrient ratios in dairy products. *Cultured Dairy Products Journal* **20** 6.

Desai SR, Toro VA and Joshi V (1994). Utilization of different fruit in the manufacture of yoghurt. *Indian Journal of Dairy Science* **47** 870-874.

DiRienzo DB (2000). Symposium: Probiotic Bacteria: Implications for Human Health. *Journal of Nutrition* **130** 382S-383S.

Elena Venir[a], Manuela Del Torre[a], Mara Lucia Stecchini[a,], Enrico Maltini[a], Paolo Di Nardo[b] (2007). Preparation of freeze-dried yoghurt as a space food. *Journal of Food Engineering* **80**(2) 402–407.

FAO/WHO (1977). Report joint FAO/WHO expert committee on the code of principles concerning milk and milk products. FAO/WHO, Rome.

FC Shukla, SC Jain, KS Sandhu (1986). Effect of stabilizers and additives on the diacetyland volatile fatty acids contents of yoghurt. *Indian Journal of Dairy Science* **39** 486–488.

Fox P F (1993). Cheese: Chemistry, Physics and Microbiology. Chapman and Hall, London.

G Houze, E Cases, B Colas, P Cayot (2005). Viscoelastic properties of acid milk gel as affected by fat nature at low level. *International Dairy Journal* **15** 1006-1016.

Ghadge PN, Prasad K, Kadam PS (2008). Effect of fortification on the physic chemical and sensory properties of buffalo milk yoghurt. *Electronic Journal of Environmental, Agriculture and Food Chemistry* **7** 2890-2899.

VR Harwalkar and M Kalab (1983). Susceptibility of yoghurt to syneresis. Comparison of centrifugation and drainage methods. *Milchwissenschaft* **38** 517–522

H Lankes, BH Ozer, RK Robinson (1998). The effect of elevated milk solids and incubation temperature on the physical properties of natural yoghurt. *Milchwissenschaft* **53** 510-513.

Hirano R, Hirano M, Oooka M, Dosako S, Nakajima I, Igoshi K (1998). Lactoperoxidase Effects on Rheological Properties of Yogurt. *Journal of Food Science* **63**(1) 35-38.
Holzapfel WH, Haberer P, Geisen R, Bjorkroth J and Schillinger U (2001). Taxonomy and Important Features of Probiotic Microorganisms in Food and Nutrition. *American Journal of Clinical Nutrition* **73** 365S–373S.
Hung MN and Lee BH (2002). Purification and Characterization of a Recombinant β-galactosidase with Transgalactosylation Activity from *Bifidobacteriuminfantis*HL96. *Applied Microbiology and Biotechnology* **58** 439–445.
Karagul Y, Wilson C and White H (2004). Formulation and Processing of Yoghurt. *Dairy Science* **87** 543-550.
KA Mccomas JR and SE Gilliland (2006). Growth of Probiotic and Traditional Yogurt Cultures in Milk Supplemented with Whey Protein Hydrolysate *Journal of Food Science* **68** (6) 2090–2095.
Lamoureux L, Roy D and Gauthier SF (2002). Production of Oligosaccharides in Yoghurt Containing Bifidobacteria and Yoghurt Cultures. *Journal of Dairy Science* **85** 1058–1069.
M Guzmán-González, F Morais, M Ramos and L Amigo (2000). Influence of skimmed milk concentrate replacement by dry dairy products in a low fat set-style yoghurt model system. Use of caseinates, co-precipitate and blended dairy powders. *Journal of the Science of Food and Agriculture* **80** 433-438.
MM Husseina, Fatma AM Hassanb, HH Abdel Daymc, A Salamac, AK Enabb, Asmaa A, Abd El-Galila (2011). Utilization of some plant polysaccharides for improving yoghurt consistency. *Annals of Agricultural Science* **56**(2) 97–103.
Mahdian E and Tehrani MM (2007). Evaluation the Effect of Milk Total Solids on the Relationship between Growth and Activity of Starter Cultures and Quality of Concentrated Yoghurt. *American-Eurasian Journal of Agriculture and Environmental Science* **2** 587-592.
Maria Vargas, MaiteCháfer, Ana Albors, AmparoChiralt, Chelo González-Martínez (2008). Physicochemical and sensory characteristics of yoghurt produced from mixtures of cows' and goats' milk. *International Dairy Journal*
Maus JE and Ingham SC (2003). Employment of Stressful Conditions during Culture Production to Enhance Subsequent Cold- and Acid-Tolerance of Bifidobacteria. *Journal of Applied Microbiology* **95** 146–154.
Mulvihill DM and MB Grufferty (1995). Effect of thermal processing on the coagulability of milk by acid. In Heat induced Changes in Milk (Ed. P. F. Fox). International Dairy Federation, Brussels (9501) 188-205.
Mustafa A Gassem, Joseph F Frank (1991). Physical Properties of Yogurt Made from Milk Treated with Proteolytic Enzymes. *Journal of Dairy science* **74**(5) 1503-1511.
O Barbaros, AK Huseyin, O Sebnem, H Adnan, A Metin (2007). Incorporation of microbial transglutaminase into non-fat yoghurt production. *International Dairy Journal* **17** 199-207.
Oliveria MN, Sodini I, Remeuf F and corrieu G (2001). Effect of milk suplementation and culture composition on acidification, textural properties and microbiological stability of fermented milks containing probiotic bacteria. *International Dairy Journal* **11** 935-942.
Ozcan T, Lucey JA, Horne DS (2008). Effect of tetrasodium pyrophosphate on the physicochemical properties of yogurt gels. *Journal of Dairy Science* **9**(12) 4492-4500.
Ozer BH, Bell AE, Grandison AS, and Robinson RK (1998). Rheological properties of concentrated yoghurt Labneh. *Journal of Texture Studies* **29** 67-79.
Rao CV, Sanders ME, Indranie C, Simi B and Reddy BS(1999). Prevention of Colonic Preneoplastic Lesions by the Probiotic *Lactobacillus acidophilus NCFM* in F344 Rats. *International Journal of Oncology* **14** 939-944.
Rasic JL and Kurmann JA (1978). Yogurt Technical Dairy Publishing House. Copenhagen, Denmark 55-68.

Robinson RK (1977). A dairy product for the future: concentrated yogurt. *South African Journal of Dairy Technology* **9**(2) 59-61
Roy D, Ward P, Champagne G (1996). Differentiation of bifidobacteria by use of pulsed-field gel electrophoresis and polymerase chain reaction. *International Journal of Food Microbiology* **29**(1)11-29.
Rao MA (1999). Rheology of fluids and semisolid foods. Aspen Publishers, Inc.
Samona A and Robinson RK (1994). Effect of Yoghurt Cultures on the Survival of Bifidobacteria in Fermented Milks. *Journal of Dairy Technology* **47** 58–60.
Saxelin M, Grenov B, Svensson U, Fondén R, Reniero, RM and Mattila-Sandholm T (1999). The Technology of Probiotics. *Trends Food Science and Technology* **10** 387–392.
SaúlAlonso,MónicaHerrero, Manuel Rendueles and Mario Díaz (2010). Residual yoghurt whey for lactic acid production. *Biomass and Bioenergy* **34**(7) 931–938.
SiminNikbinMeydani and woel-kyuHa. (2000). The American Journal of clinical nutrition **71**(4) 861-872.
Shah NP (2000). Probiotic Bacteria: Selective Enumeration and Survival in Dairy Foods. *Journal of Dairy Science* **83** 894–907.
Speck ML (1976). Interactions among Lactobacilli and Man. *Journal of Dairy Science* **59** 338-343.
StéphanMarette, JuttaRoosen, Sandrine Blanchemanche, Eve Feinblatt-Mélèze (2010). Functional food, uncertainty and consumers' choices: A lab experiment with enriched yoghurts for lowering cholesterol. *Food Policy* **35**(5) 419–428.
Tamime AY and Robinson RK (2000). YOGHURT: Science and Technology Second edition **19, 20** 375.
Tamime AY, Kalab M and Davies G (1989). Rheology and Microstructure of strained yoghurt (labneh) made from cow's milk by three different methods. *Food Microstructure* **8** 125 – 135.
Tamime AY and Deeth HC (1980). Yoghurt: Technology and Biochemistry. *Journal of Food Protection* **43**(12) 939-977.
Tatdao Paseephol, darryl M Small, Frank Sherkat (2008). Rheology and Texture of Set Yogurt as affected by Inulin Addition. *Journal of texture studies* **39**(6) 617–634.
Vinderola CG, Mocchiutti P and Reinheimer JA(2002). Interactions among Lactic Acid Starter and Probiotic Bacteria Used for Fermented Dairy Products. *Journal of Dairy Science* **85** 721–729.
Vinderola CG, Prosello W, Ghiberto TD and Reinheimer JA (2000). Viability of Probiotic (*Bifidobacterium, Lactobacillus acidophilus* and *Lactobacillus casei*) and NonprobioticMicroflora in Argentinian Fresco Cheese. *Journal of Dairy Science* 83 1905–1911.
WJ Lee and JA Lucey. Formation and Physical Properties of Yoghurt. *Asian-Australian Journal of Animal Science* **23**(9) 1127 – 1130.
Yan Wen, Ning Liu, and Xin-Huai Zhao (1998). Chemical Composition and Rheological Properties of Set-Yoghurts Prepared from Skimmed Milk Treated with Horseradish Peroxidase. Horne, D. S. Casein interactions: Casting light on the Black Boxes, the structure in dairy products. *International Dairy Journal* **8** 171-177.
YL Xiong, JE Kinsella (1991). Influence of fat globule membrane composition and fat type on the rheological properties of milk based composite gels. *Milchwissenschaft* **46** 207-212.
Younus S, Masud T and Aziz T (2002). Quality Evaluation of Market Yoghurt/Dahi. *Pakistan Journal of Nutrition* **1** 226-230.