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Wheat and Its Application in Dairy Products: A Review

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Abstract
Wheat is one of the most important crop among the cereals by area planted; followed in importance by corn, barley and sorghum. It is the best of the cereal foods and provides more nourishment for humans than any other food source. Wheat is a major diet component which supplies about more than 60% of the total daily requirements of protein and calories for the world's population. It contains minerals, vitamins, fats (lipids) and is a good source of fibers making it a highly nutritious product. Cereals and milk are blended to compensate for deficiency of lysine. The proteins from wheat in combination with milk can make up the deficiency of protein quality. Incorporation of wheat as an ingredient in dairy products would help in alleviating its nutritional value. A number of products obtained from wheat with good nutritional value such as wheat germ, aleurone flour and wheat bran are available. Fortification of dairy product with these ingredients would help in the manufacture of neutraceuticals with improved nutritional and functional properties.

Keywords: *wheat, milk, dairy products, wheat germ, aleurone flour*

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INTRODUCTION

Wheat (*Triticum* spp.) supplies about more than 60% of the total daily requirements of protein and calories for the world's population [1], and is a national staple in many countries. It is the most important crop among the cereals by area planted; followed in importance by corn, barley and sorghum [2]. The main wheat producing countries are USA, China, Russia, India, Pakistan, Canada, Argentina, Australia and some countries of European Union. India is the second largest producer of wheat in the world [3]. Wheat is classified on the basis of texture—hard and soft; color—red and white; and growth—spring and winter categories [4]. All types of wheat belong to the genus *Triticum* which is one of the largest and most important tribes in the grass *Poaceae* family [5]. Worldwide, wheat provides proteins, minerals, B-group vitamins and dietary fibers more in quantity than any other cereal crops [6, 7]. World's most cultivated species of wheat is *Triticum aestivum*. In addition, three other species are cultivated and traded—*Triticum durum*, *Triticum compactum* and *Triticum spelta* [2]. Wheat is grown on 1/4th of the world's cultivated area and accounts for 30% of the world's total grain production. Durum or macaroni wheat accounts for around 8% of the world's total area [8], which is used to produce semolina (coarse flour)—the main raw material of pasta making [9]. Cereal-based milk products are popular all over India. In general, cereal proteins are low in lysine (Lys, 1.5–4.5% versus 5.5% of the WHO recommendation), tryptophan (Trp, 0.8–2% versus 1%), and threonine (Thr, 2.7–3.9% versus 4%) [10]. The proteins from cereals in combination with milk make up the deficiency of protein quality [11]. The advent of using starch in value-added applications provides an opportunity for industry to capitalize on the unique properties of cereal starches. It is well known that milk is not a good source of iron, fiber and vitamin C. Therefore, incorporation of cereals in dairy products would also help in alleviating their nutritional value.

NUTRITIONAL ASPECTS OF WHEAT

Wheat grains are generally oval shaped and contain 2–3% germ, 13–17% bran and 80–85% mealy endosperm on dry matter basis [12]. Wheat provides 360 Kcal/100 g of energy [13]. Wheat is considered as utmost among the cereals largely due to the fact, that its grain contains proteins with unique chemical and physical properties; and it is an excellent health-building food. Besides being a rich source of carbohydrates, wheat contains other valuable components such as protein, minerals (P, Mg, Mn, Se, K, Fe, Cu and Zn) and vitamins such as thiamine, riboflavin, niacin and Vitamin E [10, 14–23].

Starch

Native starch is the main component of the wheat grain and accounts for 70–75% dry weight of the grain [12]. Normal wheat starch typically contains 20–30% amylose and 70–80% amylopectin [17, 24]. Commercially available wheat starches usually have about 12% moisture and 0.2% protein [25]. The swelling and pasting properties of native starch influences the eating quality of wheat flour noodles, particularly white noodles, which are characterized for being smooth and soft but slightly elastic [26–28]. Starch granules can be physically damaged during flour milling, increasing their water-holding ability and susceptibility to attack from the α-amylase enzyme [4].

Proteins

The protein content in wheat grain varies between 8–17%, depending on genetic makeup and external factors associated with the crop. Wheat proteins have the unique ability to form a viscoelastic network that allows for the production of products such as bread. The proteins mainly responsible for the viscoelastic properties of flour are the gliadins (prolamins) and glutenins (glutelins) [29].

Gliadins and glutenins are storage proteins and cover about 75% of the total protein content [12]. Wheat flour contains roughly the same amounts of glutenins and gliadins; and the unbalance ratio of glutenin/gliadin may change its viscoelastic properties. The glutenin fraction is, however, the major protein factor responsible for variations in dough strength among wheat varieties [30]. Glutenins are large polymeric proteins held together by disulfide bonds. These proteins give dough strength and elasticity. Gluten, comprising roughly 78–85% of total wheat endosperm protein, is a very large complex composed mainly of polymeric (multiple polypeptide chains linked by disulfide bonds) and monomeric (single chain polypeptides) proteins known as glutenins and gliadins, respectively [31]. Gliadins are smaller monomeric proteins responsible for dough extensibility. Glutenins confer elasticity, while gliadins confer mainly viscous flow and extensibility to the gluten complex. Gluten is responsible for most of the viscoelastic properties of wheat flour doughs and is the main factor dictating the use of a wheat variety in bread and pasta making [32, 33].

Hard wheats are generally bred to have higher protein content than soft wheats, although protein content and hardness are not necessarily linked. This reflects the different end use requirements of hard (>11% protein) and soft (8–10% protein) wheat flours. The main use of hard wheat flours is in bread, where strong and high levels of protein are needed. On the other hand, soft wheat flours are used in products where weaker protein (i.e., weaker dough strength and weaker viscoelastic properties) is desired, including products such as cakes and cookies. However, soft wheat flours are also used for a wide range of goods, some requiring higher levels of proteins, although not necessarily "strong" proteins such as crackers and noodles [4]

Lipids

Whole grain wheat contains approximately 2–4% and the endosperm—about 1–2% crude fat [9]. The germ has the highest amount of lipids (11%), but significant amounts are also associated with the bran and the starch and proteins of the endosperm [34]. In flour, lipids exist as either nonstarch lipids or starch lipids that are held in amylose-inclusion complexes in starch granules [35].

Nonstarch lipids can be characterized as two types—free lipids extractable with petroleum or diethyl ether, and bound lipids extractable with cold polar solvent mixtures [36]. Free lipids can be further fractionated into nonpolar lipids (triglycerides, diglycerides, monoglycerides, fatty acids, sterols, and hydrocarbons) and polar lipids (glycolipids and phospholipids). The bound polar lipids consist of phospholipids and glycolipids [37].

Fibers

Wheat bran typically contains 36.5–52.4% of total dietary fiber, more than 90% of which is water insoluble fiber [38]. The fiber content of the whole wheat grain ranges from 11.6% to 12.7% dry weight [39]. Most of the fiber that is in the outer layers of the grain (pericarp and seed coat) is usually called wheat bran. Bran is about 14.5% of the kernel weight [20, 40–42] and is one of the richest sources of fiber—46% is nonstarch polysaccharide (NSP). The main NSPs present are arabinoxylan, cellulose and beta-glucan that are respectively 70%, 24% and 6% of the NSP of the bran [43]. The concentration of soluble fiber is less than 1% in wheat (dry weight) [44, 45].

Vitamins, Minerals and Phytochemicals

Wheat germ is the embryo of the wheat kernel. The germ or embryo of the wheat is relatively rich in protein, fat and several of the vitamin B [14]. The germ contains riboflavin, thiamine, vitamin E and trace minerals such as zinc, copper, iron and magnesium [7]. Wheat bran contains a number of high value components, such as phenolic compounds, starches, soluble and insoluble dietary fibers, protein, minerals, and vitamins. Nutritionally, bran fractions produced by milling are rich in fiber, minerals, vitamin B6, thiamine, folate, vitamin E and some phytochemicals, in particular antioxidants such as phenolic compounds [46]. In general, 70% carbohydrates, 12% water, 2% fat, 12% protein, 1.8% minerals and 2.2% crude fiber are found in wheat grain kernel. It is also enriched with P, Mg, Mn, Zn, Se, Fe, K and Cu. The average concentration of Zn in whole grain of wheat in various countries is between 20–35 mg/Kg.

MEDICINAL VALUE OF WHEAT

Wheat has several medicinal virtues. Starch and gluten in wheat provide heat and energy; the inner bran coats are a rich source of phosphates and other mineral salts; the outer bran is a source of the much-needed roughage—indigestible portion that helps easy movement of bowels; and the germ provides vitamins B, vitamin E and protein which helps to build and repair muscular tissue. Nutritionally, wheat germ is rich in essential vitamins, deficiency of which can lead to various cardiovascular diseases [47]. The dietary fibers in the wheat bran help to reduce colon cancer risk along with preventing and curing some digestive disorders [48]. Wheat bran is a rich source of antioxidants [49].

Lutein is the major carotenoids present in wheat [50]. The bran/germ fraction of wheat contains greater amounts of carotenoids and antioxidant activity than the endosperm fractions [51]. Lutein, along with zeaxanthin, is important for the health of skin and eyes in humans. It helps in preventing both heart diseases and cancer, therefore, lower death rates. Protection against heart disease may stem from whole grains, antioxidants, vitamins, phytochemicals, fibers or trace minerals. Wheat also lowers the level of estrogen in the blood which reduces the risk of breast and prostate cancers [47].

ADVERSE EFFECTS OF WHEAT ON HEALTH

The adverse reactions to wheat flour may present different clinical outcomes, including celiac disease (CD), wheat allergy, Bakers' asthma, atopic dermatitis and exercise-induced anaphylaxis [52]. Wheat allergy is the result of abnormal immunological reactions to certain wheat proteins. It has totally different mechanism from that in CD and the proteins involved are not gliadins but albumins and globulins. These proteins cause Type 1 hypersensitivity reactions which are mediated by allergen-specific immunoglobulin E (IgE). Bakers' asthma is a typical condition in which water soluble flour proteins bond to serum IgE as a result of inhalation of flour particles [53]. CD or gluten-sensitive enteropathy, is a condition that results in damage to the small intestine, resulting in malabsorption. The symptoms are commonly poor growth, diarrhoea and abdominal pain. The major causative agents of CD in wheat were shown to be due to the gluten proteins—gliadins and glutenins [7]. The bioavailability of minerals present in wheat is usually low due to the presence of antinutritional factors such as phytate, trypsin inhibitor and polyphenoles. The simple traditional household technologies have been used to process the wheat in order to alleviate the effect of antinutritional factors which includes roasting, germination, fermentation, cooking and soaking [54].

CLASSIFICATION OF WHEAT AND CLASSES OF INDIAN WHEAT

Wheat produced in India is of soft to medium hard variety and with medium protein content. The important species of wheat grown in India are: Common/bread wheat (*T. vulgare* / *T. aestivum*); Durum wheat (*T. durum*); Emmer wheat (*T. dicoccum*) and Short wheat (*T. sphaerococcum*). In India, more than 90% of the area is sown to common/ bread wheat, which is grown throughout the country which is utilized mainly as flour (whole grain or refined) for the production of a large variety of leavened and flat breads, and for the manufacture of a wide variety of other baking products (Table 1) [55].

Table 1: *Approximate Composition of Different Classes of Wheat.*

Nutrients	Hard red spring wheat	Hard red winter wheat	Soft red winter wheat	Hard white wheat	Soft white wheat	Durum wheat
Food energy (Kcal/100 g)	329	327	331	342	340	339
Moisture (g/100 g)	12.76	13.10	12.17	9.57	10.42	10.94
Protein (g/100 g)	15.40	12.61	10.35	11.31	10.69	13.68
Carbohydrate (g/100 g)	68.03	71.18	74.24	75.90	75.36	71.13
Total lipid (fat) (g/100 g)	1.92	1.54	1.56	1.71	1.99	2.47
Total dietary fiber (g/100 g)	12.20	12.20	12.50	12.20	12.70	0.00
Ash (g/100 g)	1.89	1.57	1.68	1.52	1.54	1.78
Sodium (mg/100 g)	2.00	2.00	2.00	2.00	2.00	2.00
Calcium (mg/100 g)	25.00	29.00	27.00	32	34.00	34.00
Iron (mg/100 g)	3.60	3.19	3.21	4.56	5.37	3.52
Zinc (mg/100 g)	2.78	2.65	2.63	3.33	3.46	4.16

Source: USDA Food Database (2015).

IMPROVED WHEAT

Biotechnological methodologies can be used to enhance grain nutritional value or characteristics to meet certain goals. Such types of wheat are called Biotech wheat such as Low Phytate Wheat, High Folate Wheat, High Antioxidant Wheat, High Omega 3 Fatty Acid Wheat, Wheat with High Molecular Weight Glutenins, Low Calorie or Low Carbohydrate Wheat, Nonallergenic Wheat and Waxy Wheat have been reported [56].

STANDARDS

According to Food Safety and Standard Authority of India (FSSAI) definition, wheat shall be the dried mature grains of *T. aestivum* Linn. or *T. vulgare* Vill., *T. durum* Desf., *T. sphaerococcum* Perc., *T. dicoccum* Schubl. and *T. compactum* Host. It shall be sweet, clean and wholesome.

FSSAI (2011) has also specified standards for atta (wheat flour), fortified atta (fortified wheat flour), protein rich atta, maida (refined wheat flour) and semolina (suji or rawa). Wheat, wheat flour, semolina (sooji or rawa) and maida can be irradiated with minimum dosage of 0.25 kGy and maximum 1.0 kGy with average doses of 0.62 kGy (FSSAI, 2011).

MILLING OF WHEAT

Wheat is usually processed into flour for human food consumption. The flour extraction rate ranges from 73% to 77%, depending on the milling process, the variety of wheat and the cultivation conditions [57]. Milling is done to convert wheat grains into flour in which wheat germ and bran are obtained as byproducts. Wheat is milled into atta (a high-extraction flour), which is used for the production of flat breads, especially chapattis and naans. Hard wheat requires more energy to be milled into flour as compared to wheat with a softer texture, and produces coarser flour with more starch damage. Conversely, wheat kernels with softer texture produce finer flour with less starch damage, both important attributes of high-quality soft wheat flour [58]. In additions to flour, mills also produce semolina, wheat groats (white groats, couscous, bulgur, etc.) and pasta flour. The most important milling byproduct is bran, which is used by the compound feed industry

(FAO 2009). A modern wheat flour milling operation has been described by Doty [56] and Vitaglione *et al.* [38]. The development of new grinding techniques, such as jet and ultrafine milling, has been shown to be critical in improving the functionality of wheat bran [59].

Wheat grain contains nutrients B vitamins in the bran and vitamin E and polyunsaturated fatty acids (PUFAs) in the germ. During milling process, the protective cell layers are destroyed and the vitamins and PUFAs become exposed to oxidation. If the flour is stored, this can lead to loss of nutritional value, a rancid taste and yellowing of the flour. So the germ is often removed, to provide white flour or flour that can be stored for a long time. In white flour also the bran is removed, this profoundly changes the baking properties and the taste [56].

MALTING OF WHEAT

Malting is a process of converting wheat into malt. Malting of wheat is gaining prominence for food and beverages. Malting can result in reduced viscosity of foods through amylolytic breakdown of starch, thus reducing bulk [60]. A significant increase in vitamin C content after malting was found which was attributed to the enzymatic hydrolysis of starch by amylases and diastases to degrade starch and produce glucose. This increased amount of glucose becomes the precursor of vitamin C [61]. An increase in bioavailability of minerals and weight has been observed due to germination. As shown in Tables 2 and 3, the bioavailable content of Zn, Fe and Cu from wheat increased as a result of germination [18]. Germinated seeds are a good source of ascorbic acid, riboflavin, choline, thiamine, tocopherols and pantothenic acid [62]. Germination has been an effective treatment to remove antinutritional factors in cereals, e.g. phytate. These are the mobilizing secondary metabolic compounds which are thought to function as reserve nutrients [63]. Malted seeds produce finer flours with diminished starch-swelling capacity and reduced gruel viscosities [64].

Table 2: *Composition of Wheat Products Per 100 g Edible Portion.*

Wheat product	Protein (g)	Fat (g)	Carbohydrate (g)	Starch (g)	Total sugar (g)	Vitamin E (mg)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Folate (µg)
Wheat germ	26.7	9.2	44.7	28.7	16	22	2.01	0.72	45	-
Wheat bran	14.1	5.5	26.8	2	3.8	2.6	0.89	0.36	29.6	260
Wheat flour	12.6	2	68.5	66.8	1.7	0.6	0.3	0.07	1.7	51
Whole meal flour	12.7	2.2	63.9	61.8	2.1	1.4	-	0.09	-	57
White flour (plain)	9.4	1.3	77.7	76.2	1.5	0.3	0.1	0.03	0.7	22

Source: Food Standard Agency (2002).

Table 3: *Effects of Germination of Wheat on Iron, Zinc, Calcium, Manganese, and Copper Content (mg/Kg).*

	Iron	Zinc	Calcium	Manganese	Copper
Ungerminated wheat	21.2 ± 0.2	32.8 ± 1.2	402.4 ± 14.5	8.3 ± 0.2	7.8 ± 0.2
Germinated wheat	22.1 ± 0.1	33.1 ± 0.4	396.4 ± 12.6	8.1 ± 0.2	8.2 ± 0.1

Source: Luo et al. (2013).

PRODUCTS OBTAINED FROM WHEAT

Native Wheat Starch

Native wheat starch has a very broad range of application in various industries performing thickening, stabilizing functions as well as acting as energy source. Properties of starch are determined by its granular structure, polysaccharide composition (amylose/amylopectin ratio) and amount of nonpolysaccharide components (proteins and lipids) [47].

Wheat Protein Isolate

Gluten is sought after as a protein additive because of its desirable viscoelastic properties [65, 66]. Researchers have been focusing on chemical and enzymatic modifications of wheat gluten protein to enhance its water binding capacity and solubility [66, 67]. Such modifications are critical for the commercial use of wheat gluten in food formulations, because protein hydration is related to other properties of proteins, such as solubility, emulsification, foamability, viscosity, and gelation [67, 68]. Commercial production of wheat protein isolate may offer an inexpensive protein source for use in various food products and for nutritional supplementation [69].

Wheat Bran

Wheat bran—a byproduct of wheat milling process—offers unique functional as well as nutritional properties to products in terms of color, cooking performance, and their dietary fiber content [70]. Wheat bran makes up the outer layer of the wheat kernel and encompasses about 15% of the entire kernel. It is rich in dietary fibers, consisting of 13–18% protein, 14–25% starch, 3–4% fat, 3–8% minerals and 55–60% nonstarch carbohydrates based on dry matter [71]. As a byproduct of white flour production, an annual amount of 112 million tons of wheat bran is amassed worldwide, the bulk of which is currently being underutilized as forage (FAOSTAT 2012).

Aleurone Flour

Wheat aleurone flour (ALF) is a novel food product or ingredient made from the aleurone layer of cells in the wheat grain. The aleurone layer in wheat contains the highest level of bioactive components. ALF consists of primarily the aleurone layer with small amounts of bran, germ and flour. Wheat aleurone reduces inflammation and LDL cholesterol. Aleurone flour has been commercially available internationally since the mid-1990s and is sold widely as a major ingredient of bread and other cereal products such as pasta [72]

Wheat Protein Edible Film

Wheat proteins contribute both elastic and cohesive properties that are useful characteristics for nonfood products such as garbage bags. Wheat proteins also can be utilized as edible coatings for several food applications. The very specific moisture, gas and solute barrier properties of wheat gluten-based films can be used for applications involving controlled release of beneficial agents (e.g., active packaging and drug delivery concepts) or for modified atmosphere packaging techniques.

Wheat Germ Protein

Wheat germ, being a byproduct of the flour milling industry, is reported to be one of the potentially most excellent sources of much-needed vitamins, minerals, dietary fibers, calories, proteins, and some functional micro compositions at a relatively low cost. Wheat germ is potentially a nutritious food supplement; particularly, defatted wheat germ is a kind of natural high-grade protein and amino acid fortification substance [73]. Wheat germ protein has been classified with superiorly effective animal protein. It is rich in 17 amino acids, especially the essential amino acids lysine, methionine and threonine, in which many of the cereal grains are deficient.

Wheat Germ

Wheat germ, which accounts for 2–3% of the wheat grain is potentially a nutritious food supplement; particularly, defatted wheat germ is a kind of natural high-grade protein and amino acid fortification substance. The germ though a plant protein is reported to be comparable to animal protein. Wheat germ acclaimed as a nutrition capsule offers three times as much protein of high biological value, seven times as much fat, fifteen times as much sugar, and six times as much mineral content when compared with flour from the endosperm. In addition, wheat germ is the richest known source of tocopherols of plant origin and also a rich source of thiamin, riboflavin, and niacin. The presence of large amount of fats and sugars makes wheat germ highly palatable. Toasting is reported to improve its flavour [74]. Wheat germ is a byproduct of the flour milling industry, and appears to be a potential source of protein for human consumption besides being an excellent source of tocopherol, vitamin B and oil. Wheat germ contains 5.1% moisture, 24.8% protein, 1.65% ash, 6.55% crude fat, 1.44% crude fiber and 60.49% carbohydrate. Wheat germ can be effectively added to commonly prepared wheat/ refined wheat flour-based products to improve the protein quality and augment the other nutrients. In view of its high nutritive value and palatability, wheat germ offers an excellent source of proteins and vitamins for fortification of food product [75]. Wheat germ is sodium and cholesterol free, and dense in nutrients. It is rich in vitamin E, magnesium, pantothenic acid, phosphorus, thiamin, niacin and zinc. It is also a source of coenzyme Q10 (ubiquinone) and para-aminobenzoic acid (PABA) [46]

Wheat Germ Oil

Wheat germ oil is extracted from wheat germ by SC-CO_2 method. Octacosanol is the main active component of wheat germ oil. It is well known for its ergogenic properties and cholesterol lowering effects [69, 76]. Wheat germ oil is a highly rich unrefined oil, richest sources of vitamin E, A and D. It also has a high content of proteins and lecithin. It is a good source of fatty acids that are very vital for the healthy growth of the body. The germ forms only 3% of the weight of a wheat grain; nonetheless, contains about 25% of the protein, vitamins and minerals. Wheat germ oil is known for its antioxidant properties. Since it has exceptional nourishing qualities, it is used in lesser quantities for preparing the carrier oil blend [47]

APPLICATION OF WHEAT IN DAIRY PRODUCTS

Traditional Dairy Products

Chhana podo: Chhana podo is the only traditional baked dairy product in India and comprises chhana (Indian cottage cheese) and sugar as essential ingredients [77]. Ghosh *et al*. [78] stated that chhana podo should have a light brown color and a cake-like soft spongy body. It should be sweet, with a rich fat taste and a cooked flavour. The puffed, brown coloured crust product has a spongy, soft texture. To prepare chhana podo, the milk has to be standardized to 4–4.5% fat, maida/suji is recommended at 5% level, while sugar is required at levels ranging from 25–35% and water may be used at the rate of 30% by weight of chhana. The product is baked at 150–200 °C for 50–80 min [79].

Paneer*:* Paneer is a type of soft, unaged, acid-set, nonmelting curd cheese made by curdling heated milk with lemon juice, vinegar or any other food acid. It is native to India but now consumed in middle-east also. Narayanan [80] prepared a value-added paneer by including whole cereal flour of wheat and finger millet at 1% to improve the fiber content in otherwise fiber-deficient paneer.

Jalebi*:* It is a sweetened fermented product made from maida (refined wheat flour), dahi and water. The fermented batter is deep fat fried in oil in spiral shapes and immersed in sugar syrup for few minutes [11].

Gulabjamun*:* Gulabjamun is a khoa-based sweet soaked in thick sugar syrup, generally served warm as a dessert. Khoa (300 g) is mixed with wheat flour (35 g) and baking powder (3 g) and kneaded into uniform dough. The dough is rolled into small balls and deep-fried in ghee in a shallow pan until the balls acquire a golden brown color. The balls are then removed and placed in a 60% sugar solution and allowed to soak for a few hours before being served [81].

Gulabjamun mix powder: Gulabjamun mix powder is formulated from skimmed milk powder (SMP), hydrogenated vegetable fat, maida (refined wheat flour), semolina (product of wheat milling), baking powder, ground cardamom with or without whey protein concentrate (WPC). Instant Gulabjamun mix has been prepared using a blend of spray dried WPC and SMP (40:60, w/w); whey protein subjected to a pretreatment of 90 °C for 10 min for denaturation gave best results. Other ingredients in the formulation were 25% refined wheat flour, 2% baking powder and 15% butter [79].

Doda burfi: Doda burfi (Indian milk cake) is an indigenous sweetmeat of northern India and is considered a delicacy to be served on special occasions in states like Punjab, U.P., Haryana and Rajasthan. It is also commonly known as "Doda", "Dhoda" or "Dhodha". The product is made from germinated wheat flour (angoori atta), buffalo milk and sugar along with certain optional ingredients such as various nuts for garnishing and is characterized by pleasant caramelized flavour, dark brown color and sticky granular body. The product contains most of the nutrients in predigested form and serves as an excellent source of dietary fibers, usually absent in dairy products [82, 83].

Sohan halwa: Sohan halwa is a germinated wheat-based buffalo milk product, popular in North India. It has an extremely chewy texture, which is attributed to the simultaneous presence of wheat gluten and casein.

Ghevar: Ghevar—a milk sweet prepared from admixture of wheat flour—is a rare delicacy of Rajasthan. Its body has a characteristic miniaturized honey comb structure that is spongy and chewy with sugar layer on top providing a glossy appearance.

Padusha: Padusha (makkhan bada) is a fried South Indian sweet, consisting of maize or wheat flour, dahi, ghee and milk, the last being used as a kneading medium.

Rasogolla: Freshly-made channa is kneaded and rolled into balls of about 15–20 mm diameter with a smooth surface and no cracks. The dough balls are cooked in boiling sugar syrup (60% concentration) for about 15 min. After the cooking is complete, the balls are transferred to a container with water at 30–35 °C for texture stabilization and color improvement of the balls. After 5–10 min of texture stabilization in water, the balls are transferred to 40% sugar syrup [11].

Suji ka halwa: Wheat sooji (semolina) halwa is a highly popular product of Indian confectionary which is relished all over Indian subcontinent and prepared by roasting the semolina in vanaspati (hydrogenated fat) followed by addition of sugar and water [84]. Instant halwa mix developed earlier by Arya and Thakur [85] with a shelf-life of one year provided high convenience and required just 4–5 min heating in boiling water for reconstitution. It has been highly liked by Armed Forces and became popular among civilians as well.

***Halwasan**:* Halwasan is traditionally manufactured in Khambhat/Cambay region which is an ancient sea port of Gujarat since more than 125 years. It is heat desiccated, milk-based sweet prepared from the mixture of milk and sprouted wheat fada (pieces). It is sweetened and after desiccation, it is richly coloured, flavoured and decorated using nutmeg, cardamom, pistachio and saffron. Thus, traditionally made sweet is a rich source of nutrients derived from milk solids as well as high quality of germinated Bhalia wheat solids [86].

Sohan papdi: Sohan papdi is another popular traditional sweet, made with chickpea flour and/or refined wheat flour, sugar and fat. It is characterized by its soft texture with thin sugar strands. The flours (400 g) are sifted and roasted in fat (250 g) until light golden and cooled. Sugar (300 g) syrup is prepared and poured into flour mixture and is well beaten with a large fork to form thread-like flakes. The mass was poured into greased surface, rolled into 25 mm thickness and cut into squares [87].

Badusha: Badusha is one of the popular traditional sweet prepared using refined wheat flour and fat as main ingredients. It has soft flaky texture with sugar syrup embedded. Baking soda and refined wheat flour are sieved, yoghurt, little sugar and fat are beaten together to make a foaming consistency and mixed with refined wheat flour to make a spongy dough. Small lemon-sized balls were made from the dough, pressed to flatten, kept in a refrigerator for 10 min, fried in fat, and then soaked in sugar syrup [87].

Rabadi: Rabadi is a cereal and buttermilk-based staple traditional recipe of Western region of India. Wheat flour or refined wheat flour (100 g) was mixed with buttermilk (250 ml). It was diluted with plain water (600 ml). Salt (3 g) was added at the time of cooking. For fermentation, this homogenized mixture was kept in an incubator at 37 °C. Samples were cooked by boiling for 5 min followed by simmering for 25 min with constant stirring. A little amount of buttermilk was used as a starter for fermentation for 16 h after cooking [88].

Satori: Satori is prepared by proper combination of khoa, semolina and sugar. These ingredients were lightly warmed on a nonstick pan. Then a ball of nearly 60 g was made from these ingredients which was covered by thin puree or chapatti of wheat flour dough and then subjected to shallow frying by smearing little ghee on nonstick pan till it attained a reddish-brown color [89].

Mustafakemalpasa: Mustafakemalpasa dessert is also known as cheese dessert. The name of the dessert has been attributed to the town owning the same name, Mustafakemalpasa (Bursa, Turkey), where the sweet was originated. The dessert dough has to be prepared with high-quality wheat (*T. aestivum*) flour, fresh unsalted cheese, semolina flour, eggs, drinking-quality water, baking powder, and other additives. The baking process to reduce moisture content in the sweet to less than 10% is a descriptive step of manufacturing. The sweet can be single- (280–300 °C) or double-baked (280–300 ^{o}C) followed by drying at 130–150 ^{o}C [90].

Wheat porridge: Wheat porridge is a common breakfast food in several countries. It is conventionally prepared by boiling wheat grits in water, known as dalia in South East Asian countries, frequently by adding milk and sugar for enhancing acceptability. Further, it is also consumed as a savoury dish after cooking wheat grits with water, salt, spices and vegetable pieces. Coarse grinding of either polished or unpolished wheat is practiced in a plate mill followed by cleaning and sieving to obtain grits of particle sizes between 300 and 850 µm [91]; these grits are used for preparing dalia. Rufian-Henares *et al.* [92] reported the method of manufacture of wheat porridge with soy protein isolate and SMP. Instant wheat porridge (Dalia) mix based on precooked broken wheat, sugar, SMP and flavouring agents was developed by Khan *et al.* [84].

Halubai*:* Halubai is a popular traditional sweet in India, relished for its soft, smooth texture and delicate aroma. It was prepared by soaking and grinding single whole wheat and rice grain to a fine paste, starching it through a cloth, cooking the resultant dispersion over a low flame with constant stirring with intermittent addition of ghee. To this dispersion, jaggery solution was added and cooked further. Use of coconut milk is optional in this product (that provides considerable fat and contributes to the flavour). A modified method for the preparation of halubai was developed by Asha *et al.* [93] which is energy efficient and time saving without compromising the quality of the product.

Fermented Dairy Products

Wheat Fermented Milk Beverage: Synbiotic are those products which contain both probiotic bacteria and prebiotic. Probiotic bacteria are good for our gut such as *Lactobacillus acidophilus*, *Bifidobacterium lactis* and *Streptococcus salivarius* subsp. *Thermophilus.* Prebiotic is the substrate for the probiotic bacteria. El-Zainy *et al*. [94] prepared a wheat fermented milk beverage using 15% wheat extract (obtained by soaking, cooking and pressing wheat) and cow milk.

Kishk: A fermented product prepared from parboiled wheat and milk. It is consumed in Egypt and in most Arabian countries. It is prepared by boiling wheat in water to soften it, then washed and ground and then moisten in salted water. Then a paste is made by mixing it with concentrated sour milk and then diluted using water or milk and then fermented for 24 h and then it is sun dried after forming small balls [95].

Tarhana: Tarhana is a traditional Turkish fermented food product. It was produced by mixing wheat flour, yoghurt, yeast, vegetables (tomatoes, onions, green and red peppers), salt and spices (including mint and thyme), followed by fermentation for 1–7 days at room temperatures around 25–30 °C [96, 97]. Tarhana fermentation is usually carried out by using yoghurt bacteria, *Lactobacillus bulgaricus*, *Streptococcus thermophilus* and Bakers' yeast (*Saccharomyces cerevisiae*) [98]. The dough at fermentation is called wet tarhana. Afterwards, the dough was dried in sun or by dryer as a lump, nugget or thin layers to obtain dry tarhana. Finally, it was ground to powder < 1 mm. Tarhana is usually reconstituted with water and served as a hot soup. Tarhana soup can be prepared from wet or dry tarhana [99–101]

Weaning Foods: Weaning formulations based on germinated wheat flour, mungbean flour, sugar and SMP was developed with the formulations of 44% germinated wheat flour, 36% mungbean flour, 10% SMP and 10% sugar [102]. Weaning food formulations have been developed by incorporating wheat flour (40%), green gram Dhal flour (10%), sugar (27%) and wheat malt (8%) to provide 15–17% protein, 360–380 Kcal of energy and fortified with vitamins and minerals to meet the recommended daily allowance [103].

Use of Wheat Products in Other Dairy and Nondairy Products

Imitation Cheese: Imitation cheese can be prepared using water, rennet casein, wheat starch (0–20%), vegetable fat, emulsifying salts, sodium chloride and sorbic acid. At concentrations of 3–9% (w/w), wheat starch behaves like a filler material without affecting the acceptability of such cheeses [104].

Cottage Cheese: Cottage cheese curds can be manufactured by acid coagulation of skim milk, typically through starter culture (*Lactococcus lactis*, *Lactococcus cremoris*) activity. Addition of flakes from germinated wheat grains at 3% by weight to the cottage cheese increases the concentration of α and ɣ tocopherol, vitamin B6 as well enrich with dietary fibers and develop new sensory properties of the product [105].

Set Yoghurt*:* Yoghurt is obtained by coagulating milk formed by starter culture consisting of *Streptococcus thermophilus* and *Lactobacillus delbruckii* subsp. *Bulgaricus*. Yoghurt can be classified into set**,** stirred, and fluid according to the final end use and consistency. It is consumed as a meal or snack or used as an ingredient. Set yoghurt has a compact soft body and stabilizers are used in such type of yoghurts. Schmidt *et al.* [106] prepared a set yoghurt using gelatine (control), native wheat starch (NWS) and modified wheat starches (MWS) (acetylated cross-linked, hydroxypropylated or hydroxypropylated cross-linked) as stabilizer. This study showed that the characteristics of yoghurt formulated with NWS and gelatin were similar. So NWS may be used as an alternative stabilizer. The MWS-stabilized yoghurts were stable but had different consistencies than gelatin and NWS-stabilized yoghurts.

Strained Yoghurt*:* Strained yoghurt is prepared by reducing the content of water in yoghurt (about 70%) by removing yoghurt whey. Cloth bag as a traditional method and ultrafiltration and centrifugation as new methods are used for removing yogurt whey. Seçkin and Baladura [107] evaluated the effect of addition of wheat dietary fibers (1%, 2% and 3%) on color, texture and sensory properties of strained yoghurt during cold storage. The panelists found wheat fiber-strained yoghurts acceptable.

Synbiotic Yoghurt*:* Synbiotic yoghurt contains probiotic bacterial strains and prebiotic. Prebiotics are the substrate for probiotic bacteria. The byproduct of wheat such as wheat bran are rich source of dietary fiber which has many health advantages such as decrease of the danger of coronary diseases, diabetes, and some cancers in addition to nonfragmentation and nondigestion in intestine which have many advantages in improving the performance of digestive system especially small intestine [108]. So Tavakoli *et al.* [22] tried to prepare a symbiotic yoghurt using wheat fiber and found that despite decreasing the pH during storage, the prebiotic compounds caused increase in growth and survival of *Lactobacillus bulgaricus* and *Streptococcus thermophillus* in the yoghurt produced.

Ice Cream*:* Ice cream is a frozen dairy product, manufactured by freezing and aerating a pasteurised mixture of ingredients including milk products, sugars, emulsifiers, stabilisers, flavourings and colourings. Solubilized wheat protein isolate (SWPI) has got foaming capacity/stability, water holding and fat absorption capacities, and emulsifying capacity/stability. Ahmedna *et al.* [69] made an attempt to make an ice cream containing 5%, 10%, 15% and 20% SWPI and found that ice cream containing 10% SWPI were acceptable to consumers.

FUTURE SCOPE

Wheat has been used as an ingredient in a number of traditional Indian dairy products. However, standardized method for manufacture of these products and details regarding physicochemical, microbiological and nutritional aspects on these products are lacking which would help in commercial manufacture of such products.

A number of products obtained from wheat with good nutritional value such as wheat germ, ALF, wheat bran are available. Fortification of dairy product with these ingredients would help in the manufacture of neutraceuticals with improved nutritional and functional properties.

CONCLUSION

Cereal-based milk products are popular all over India. Cereals and milk are blended to compensate for deficiency of lysine. The proteins from wheat in combination with milk can make up the deficiency of protein quality. The level of starch in wheat ranges between 60–80%. The advent of using starch in value-added applications provides an opportunity for industry to capitalize on the unique properties of cereal starches. It is well known that milk is not a good source of iron and fiber. Therefore, incorporation of wheat as an ingredient in dairy products would help in alleviating its nutritional value.

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