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Physicochemical and functional properties of yoghurt powder

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Abstract
The aim of this work was to investigate the physical, chemical and functional properties of yoghurt powder prepared by air drying of low fat yoghurt so that it can be used as a conclusive dairy ingredient for value addition and nutrition. For that fresh yogurt was air dried in electric tray dehydrator in 3-5mm at 55-60 °C temperature at air velocity 1.5m/s. Evaluation of moisture value, fat value and ash value was done to study the proximity of yoghurt powder. Tests such as pH, titratable acidity, vitamin C and DPPH were applied to study the chemical properties of yoghurt powder. Study of the bulk properties was done so as to reduce the storage and transportation volume of product. Carr's compressibility index and Hausner ratio were applied to study the flow ability. Wettability, dispersibility, water absorption capacity, solubility, free fat, and sedimentation were conducted for finding the functional properties of yoghurt powder.

Keywords: Physicochemical, functional, yoghurt powder, analytical mill, chemical properties

1. Introduction

India is the largest milk producer in the world accounting 18.5% of total milk production with 146.3 million tons (Anonymous, 2015) [1]. Food processing sector plays an important role in diversification of agricultural activities and improvement of value addition opportunities for overall progress of country which depends on effectiveness of processing sector. In 2013, 7% of total milk production was converted into yoghurt (Bibiana, *et al.*, 2014) [5]. Various names have been used to refer to yoghurt or similar products such as, *Dahi* or *Dahee* in India, *Fiili* in Finland and *Roba* in Iraq (Tamime, *et al.*, 1980) [29], (Tamime, *et al.*, 1985) [30]. According to Code of Federal Regulations of FDA (FDA, 1996) [7], yoghurt is "food produced by culturing one or more of the optional dairy ingredients (cream, milk, partially skimmed milk, and skim milk) with a characteristic bacterial culture that contains lactic acid-producing bacteria, *Lactobacillus delbrueckii subsp. bulgaricus* and *Streptococcus thermophilus*". Significant microbial growth and high nutrient utilization are responsible for the consumption of yoghurt, because of increased protein digestibility (Kumar, *et al.*, 2005) [19]. Health benefits of yoghurt can be divided into two groups: nutritional attributes that are expressed as a function of nutritional supply, such as protein, lactose, vitamins, calcium and physiological attributes are expressed as the function of providing prophylactic and therapeutic benefits other than nutritional benefits, like antimicrobial activity, gastrointestinal infections, reduction in serum cholesterol and immune system stimulation (Shah, *et al.*, 2006) [25], (Ashraf, *et al.*, 2011) [3]. Milk proteins in yoghurt are of good quality because of their high biological value. These proteins provide many essential amino acids. Rich nutrition of yoghurt decreases the risk of colon cancer (Weerathilake, *et al.*, 2014) [33]. Yoghurt is recommended for the person having lactose intolerance, gastrointestinal disorders, irritable bowel disease and also aids in weight control. Lactic acid helps in the absorption of minerals in intestine which aids in weight control (Renner, 1986) [23], (Weerathilake, *et al.*, 2014) [33].

Production of dried milk products have become an increasingly important segment of the dairy sector. Shelf life of yoghurt is higher than that of milk, but it is still susceptible to microbial and chemical spoilage. Acidity of yoghurt creates an unfavorable environment for spoiling micro-organisms (Gilliland, 1991) [8]. Due to high water content, shelf life of yoghurt is not high, i.e., 1 day under ambient storage condition (25–30 °C) and 5 days at 7 °C, which disturbs its commercialization (Kumar, *et al.*, 2005) [19]. Yoghurt maintained at 2–4 °C temperature throughout the distribution chain has good quality and it also adds to the cost of the yoghurt. Yoghurt powder, with a longer shelf life, can reduce transportation and storage cost (Koç, *et al*., 2010) [16]. Main aim of yoghurt drying is to preserve it in a stable form of good quality without any refrigeration. At 21 ºC, shelf life of yoghurt powder remains good for 6 months when ascorbic acid and monosodium glutamate were added in the yoghurt before its drying (Kumar, *et al.*, 2005) [19]. Therefore, first step of the current project was to test whether the production process could be proper or not. Concepts, lab possibilities, and technical understanding were considered for this purpose. Electric dehydrator is a small electrical appliance for drying of small tonnage products. Cabinet dehydrator can be used for drying of small batches up to 4000kg that may be in liquid, paste, slurry, powder, granule or solid form initially. This dryer offers good control and low cost but is of low capacity and labour intensive (Korte, 2001) [18]. Air drying system for yoghurt was characterized at 70 ºC (Jaya, 2009) [10]. Despite this, air drying process for yoghurt is not well understood well till date.

Physical, chemical and functional properties of yoghurt powder dried by hot air have not yet been studied. Properties of food powders can be divided into two groups, as physical and chemical properties. Yoghurt powder is used as an ingredient for preparation of many foods like yoghurt drink mixes, instant drink mixes, confectioneries, bakery foods, soup bases, sauces and for direct consumption after reconstitution. Yoghurt powder can also be applied topically as a coating on cereals. Antitumor activity of yoghurt powder is related to cell wall of starter bacteria and so the activity remains even after drying (Kirru, *et al*., 2011) [15]. The present study was conducted to study the physicochemical and functional properties of air dried yoghurt powder.

2. Material and Methods

2.1. Experimental procedure

Present study was carried out in the laboratories of Department of Food Technology, Guru Jambheshwar University of Science and Technology, Hisar, India. Low fat (0.4071%) plain yoghurt was procured from local market, Hisar, India, in sealed 5kg plastic *matki* and analyzed for confirmation of labeled information.

2.2. Preparation of air dried yoghurt powder

Yoghurt powder used in this study was prepared as per the air-drying procedure (Jaya, 2009) [10]. A quantity of 4kg of low fat yogurt was filtered through a muslin cloth and then spreaded (3-5mm) in polyester trays reformed manually from polyester films. Trays were kept in an electric tray dehydrator (Voltstar Power System) at 55-60 °C under 10-11% humidic condition for 4.5 to 5.0 hours. Dried yoghurt pellets were collected and ground in an analytical mill (28000 rpm for 1min).

2.3. Proximate evaluation of yoghurt powder

2.3.1. Moisture content

Moisture content was determined using the hot air oven method (Kirru, *et al*., 2011) [15].

2.3.2. Crude fat content

Crude fat content was determined using the Soxhlet solvent extraction method (Sulaksono, *et al*., 2013) [27].

2.3.3. Ash content

Ash content was determined using the direct heating method (Sulaksono, *et al*., 2013) [27].

2.4. Chemical properties of yoghurt powder

2.4.1. pH

The pH was determined using the method as described by Sharanagouda (Sharanagouda, 2011) [26]. According to this method, 1g of sample was dissolved in 10ml of distilled water. Mixture was allowed to equilibrate for 3min and pH was determined by inserting electrode of digital pH meter (Biogen Scientific, Delux pH meter) in the sample.

2.4.2. Titratable acidity

Titratable acidity was determined using the method as described by Sharanagouda (Sharanagouda, 2011) [26].

2.4.3. Vitamin C

Vitamin C was determined using the method as described by FSSAI, 2012. According to this method, 10gm of the sample was taken and made up to 100mL with 3%HPO_3. It was then filtered and 10mL of filtrate was titrated against standard 2, 6-Dichlorophenol-indophenol dye to a pink end point. Vitamin C in mg/100g was expressed as;

$$\text{Vitamin C} = \frac{\text{Titre value} \times \text{Dye factor} \times \text{Vol. made up} \times 100}{\text{Vol. of filtrate taken} \times \text{Weight of sample}}$$

by Inchuen *et al.* (Inchuen, *et al*., 2010) [9]. According to this method, 0.4ml of the extract was mixed with 5ml of 40% ethanol solution and 0.6ml of 0.8mmolL^{-1} of DPPH solution. Mixture was shaken vigorously and left to stand for 30min. Absorbance was measured at 517nm in the UV-visible spectrophotometer. DPPH % expressed as;

$$\text{DPPH} = 1 - \frac{\text{Sample absorbance}}{\text{Control sample absorbance}} \times 100$$

2.5. Bulk properties of yoghurt powder

2.5.1. Loose bulk density

Loose bulk density was determined using the method as described by Jinapong *et al.* (Jinapong, Suphantharika and Jamnong 2008). According to this method, 100ml graduated cylinder was weighed. Yoghurt powder sample was introduced into cylinder up to 100ml mark. Noted the weight of powder taken in cylinder and loose bulk density in g/cm^3 was expressed as;

$$\text{Bulk Density} = \frac{\text{Weight of powder}}{100}$$

2.5.2. Tapped bulk density

Tapped bulk density was determined using two methods as described by Koc *et al.* and Kirru *et al.* with some modifications (Koc, *et al.* 2014) [17], (Kirru, *et al*., 2011) [15]. According to these methods, 100g of powder was poured in measuring cylinder. Cylinder was tapped manually 100times (until a constant volume reached). Volume was noted and tapped bulk density was expressed in g/cm^3;

$$\text{Bulk Density} = \frac{100}{\text{Vol. of powder afetr tapping}}$$

2.5.3. Particle density

Particle density was determined using the method (Atomizer, 1978) [4]. According to this method, 10g of the sample was weighed into measuring cylinder. Added 18ml of the petroleum ether and shaken. Rinsing of cylinder wall was done with a further 6ml of ether making the total volume of ether as 24ml. Total volume of ether with suspended powder was recorded. Particle density in g/cm^3 expressed as;

$$D_{Particle} = \frac{W}{V - 24}$$

Where, W was weight of sample (g), V was volume of powder + petroleum ether (ml).

2.5.4. Occluded air content

Occluded air content was determined using the method as described by Atomizer (Atomizer, 1978) [4]. Occluded air content in cm^3 was expressed as;

$$D_{Solid} = \frac{100}{\frac{F}{0.94} + \%W + \frac{\%\,SNF}{1.52}}$$

$$V_{Occluded} = \frac{100}{D_{Particle}} - \frac{100}{D_{Solid}}$$

Where, D_{Solids} was density of powder solids (g/cm^3), F was fat content in percentage, %SNF was solids-not-fat content in percent and W was moisture content of sample.

2.5.5. Interstitial air content

Interstitial air content was determined using the method as described by Atomizer (Atomizer, 1978) [4] for particle density. Interstitial air content in cm^3 was expressed as;

$$D_{Interstitial} = \frac{100}{D_{Solid}} - \frac{100}{D_{Particle}}$$

2.5.6. Flowability and Cohesiveness

Flowability (as a static measure for flowability) and cohesiveness were determined using the method as described by Thiengnoi *et al.* (Thiengnoi, *et al*., 2012) [31] in terms of Carr index (CI) and Hausner ratio (HR) respectively. These were expressed as;

$$CI = \frac{\text{Tapped density} - \text{Bulk density}}{\text{Tapped density}} \times 100$$

$$HR = \frac{\text{Tapped density}}{\text{Bulk density}}$$

2.6. Functional properties of yoghurt powder

2.6.1. Wettability

Wettability was determined using the method as described by Atomizer (Atomizer, 1978) [4] with some modifications. Hundred ml distilled water (50 ºC) was poured into a 200mL beaker. A paper funnel reformed of Whatman No. 42 filter paper with a hole of 1.85cm diameter was held on a tripod set over beaker maintaining 9cm height between the water surface and bottom of paper. One g sample was poured and wetting time in seconds was recorded.

2.6.2. Dispersibility

Dispersibility was determined using the method as described by Selamat *et al.* (Selamat, *et al*., 2007) [24]. According to this method, 5g of the sample was made up with distilled water to 250mL. It was shaken frequently for 5min and then allowed to stand undisturbed overnight. Centrifuged at 2500 rpm for 20min and 25mL of the supernatant was pipetted into a weighed dish. Residue was dried in oven at 105 ºC for 3h and weighed again. Percent dispersibility was expressed as;

$$\text{Dispersibility} = \frac{\text{Weight of dissolved solids}}{\text{Weight of sample}} \times 100$$

2.6.3. Water absorption capacity

WAC was determined using the centrifugation method (Aremu, *et al.*, 2008) [2]. According to this method, 1g of the sample was weighed and added 10ml of distilled water to it. Resulting suspension was stirred using a magnetic stirrer for 5min. Centrifugation was done at 3500 rpm for 30min. Volume of supernatant was noted. WAC in ml/g expressed as;

$$WAC = V_1 - V_2$$

Where, V_1 was initial volume of water added and V_2 was volume of supernatant.

2.6.4. Water absorption index and Water solubility index

WAI and WSI were determined using the method as described by Kavitha *et al.* (Kavitha, *et al.*, 2013) [12]. According to this method, 2.5g of the sample was dispersed in 30ml of distilled water, cooked at 90 °C for 15min and cooled to room temperature. Then centrifuged at 3000 rpm for 10min. Supernatant was decanted into a dish and weight of the sediment was noted. Weight of dry solids in supernatant was determined by evaporating the supernatant at 110 °C. Water absorption index and Water solubility index in g/100g expressed as;

$$WAI = \frac{\text{Weight of sediment}}{\text{Weight of sample}}$$

$$WSI = \frac{\text{Weight of dissolved solids}}{\text{Weight of sample}} \times 100$$

2.6.5. Insolubility index

Insolubility index was determined using the method as described by Sharanagouda (Sharanagouda, 2011) [26]. According to this method, 1.4g of the sample was poured in 10ml of distilled water at 40 °C and blending was done in insolubility index mixer for 10sec. Foam was removed from surface and content was transferred into 13ml pre-weighed centrifuge tubes. Centrifugation was done at 3000 rpm for 10 minutes. Supernatant was decanted and water was added to the residue to make volume 5ml. Centrifugation was done again for 5min. Weight of the sediment was noted as the insolubility index.

2.6.6. Surface free fat

Surface free fat was determined using the method as described by Buma (Buma, 1971) [6]. According to this method, 10g of the sample was mixed slowly with 50ml of the petroleum ether for exactly 15min. Mixture was filtrated and 25mL of the filtrate was evaporated. Residue was weighed and the free fat percentage was calculated either based on total fat or based on powder. Percent free fat was expressed as;

$$\text{Free fat} = \frac{a \times 50 \times 100}{[c - (\frac{a}{0.94}) \times b]}$$

Where, as was evaporation residue in g, c was filtrate taken out with pipette in ml and b was g of powder used.

2.6.7. Sedimentation

Sedimentation was determined using the method as described by Selamat *et al.* (Selamat, *et al*., 2007) [24]. According to this method, 10g of the sample was made up to 100ml with distilled water. Mixture was shaken vigorously for 5min and poured 10ml of it into each three volumetric cylinders. Kept undisturbed for 45min. After 45min, volume of sediment was measured and % Sediment expressed as;

$$\text{Sediment} = \frac{\text{Sediment residue(ml)} \times 100}{\text{Initial volume(10ml)}}$$

2.7. Statistical analysis

All experiments were conducted in three replicates. All values observed were expressed as mean values ± standard deviation. A statistical software, OP Sheoran Statistical Software (OPSTAT) was used to analyze and represent the values.

3. Results and Discussion

3.1. Proximate composition of yoghurt powder

The results of proximate composition of yoghurt powder are presented in Table 1.

The moisture content of air dried yoghurt powder was 7.290%±0.68%. This value is comparable to those observed by (Koç, *et al*., 2010) [16] who reported that the moisture content of yoghurt powder dried by using spray drying method was 6.92%. The moisture value observed in this study is slightly higher. The reason for this high moisture level is the use of dehydrator that had some other food samples having high water content which increases moisture level of environment in the dryer consequently affecting the drying process. The other reason could be the fact that yoghurt layer was thicker and heat could not penetrate properly. Greater the temperature difference between product and drying air, greater the heat transfer and evaporation rate.

The crude fat content of the yoghurt powder was found to be 16.198%±0.73%. This value is different from those observed by (Sulaksono, *et al*., 2013) [27] who reported that the crude fat content of yoghurt powder analyzed was 36.2%. The reason for lower fat content is use of low fat yoghurt in this study. The other reason could be the fact that a little amount of yoghurt fat was left on the polyester tray after removing the dried pellets from tray. Drying conditions also affect fat content, longer the drying time higher would be the fat oxidation which reduces the fat content (Takiyah, *et al*., 2007) [28]. The ash value of the yoghurt powder was 5.779%±0.02%. This value is comparable to those observed by (Sulaksono, *et al*., 2013) [27] who reported that ash content of yoghurt powder was 6.7%. The ash value is an indicator of mineral content in product, which are needed in the development of bones, teeth and body functions (Bibiana, *et al*., 2014) [5].

Table 1: Result of Proximate composition of yoghurt powder

Parameter (%)	Observed value
Moisture content	7.290±0.68
Crude fat content	16.198±0.73
Ash content	5.779±0.02

Values are mean ± SD, n=3

3.2. Chemical properties of yoghurt powder

The results of chemical properties of yoghurt powder are shown in Table 2.

pH of yoghurt powder was 4.427±0.005. This value is comparable to those observed by (Koç, *et al*., 2010) [16] and (Sulaksono, *et al*., 2013) [27] who reported that pH of spray dried and foam-mat dried yoghurt powder was 4.17 and 4.6, respectively. The reason for difference in pH could be attributed to the fact that there may be slight difference in yoghurt sample. Other reason behind this may be that the fat was oxidized during drying process which might have resulted in increase in acidity. The titratable acidity of yoghurt powder was observed as 0.707%±0.026%. This value is comparable to value 1.12% observed by (Koç, *et al*., 2010) [16].

Vitamin C of yoghurt powder was found to be 2.158±0.074 mg/100g. Milk is not rich in vitamin C. It is also one of the most sensitive and heat labile vitamin.

Antioxidant activity as indicated by DPPH method in yoghurt powder was 31.777%±4.106%. No report could be found on this aspect of yoghurt powder. However, it was observed that DPPH activity of soy yoghurt is 52% (Yadav, *et al*., 2012) [34].

Table 2: Result of chemical properties of yoghurt powder

Parameter	Observed value
pH	4.427±0.005
Titratable acidity (%LA)	0.707±0.026
Vitamin C (mg/100g)	2.158±0.074
DPPH (%)	31.777±4.106

Values are mean ± SD, n=3

3.3. Bulk properties of yoghurt powder

The results of bulk properties of yoghurt powder are presented in Table 3.

The loose bulk density and packed/tapped bulk density of the yoghurt powder were 0.599g/cm^3±0.01g/cm^3 and 0.801g/cm^3±0.01 g/cm^3, respectively. Loose bulk density is comparable to those observed in an earlier study (Kirru, *et al*., 2011) [15] and (Koc, *et al*., 2014) [17] wherein it was reported that the loose bulk density of spray dried yoghurt powder analyzed was 0.5g/cm^3 and 0.54cm^3, respectively. Packed bulk density is comparable to those obtained by earlier workers (Koc, *et al*., 2014) [17] who reported that packed bulk density of spray dried yoghurt powder was 0.75g/cm^3. Particle size plays vital role in the bulk properties. Particle size and air entrapped in smooth particles with spherical shape are inversely proportional to the bulk density (Kirru, *et al*., 2011) [15].

The particle density of the yoghurt powder was 0.778g/cm^3±0.01g/cm^3. This value is comparable to those obtained in a study by Koc *et al.* in which it was reported that the particle density of spray dried yoghurt powder analyzed was 1.18g/cm^3. Average particle density of food powders is 1.4 g/m^3 (Koc, *et al*., 2014) [17].

Occluded air content and interstitial air content of the yoghurt powder were 42.975cm^3±1.10cm^3 and 38.591cm^3±2.16 cm^3, respectively. No report could be found on this aspect of yoghurt powder.

Flowability and cohesiveness of the yoghurt powder were found to be 25.231%±0.98% and 1.338±0.02, respectively. Flowability is comparable to those obtained by earlier workers (Koc, *et al*., 2014) [17] who reported that spray dried yoghurt powders have lower flowability with flowability of only 27.9% due to the small size of particles. Lower value indicates free flowing behaviour. The powders having flowability in range of 22-35% have poor flow description (Moghbela, *et al*., 2013) [21]. Cohesiveness of yoghurt powder is comparable with those obtained in a previous study by

(Moghbela, *et al*., 2013) [21] where it was reported that cohesiveness values below 1.25 indicates good flowability and the value greater than 1.5 indicates poor flowability. Value obtained in this study was slight higher than 1.25, so the powder had bit good flow description. As per FSSAI, lack cohesiveness can however be handled by using additive sodium aluminium silicate up to 0.05%.

Table 3: Result of bulk properties of yoghurt powder

Parameter	Observed value
Loose bulk density (g/cm^3)	0.599±0.01
Tapped bulk density (g/cm^3)	0.801±0.01
Particle density (g/cm^3)	0.778±0.01
Occluded air content (cm^3)	42.975±1.10
Interstitial air content (cm^3)	38.591±2.16
Flowability/Compressibility (CI) (%)	25.231±0.98
Cohesiveness (HR)	1.338±0.02

Values are mean ± SD, n=3

3.4. Functional properties of yoghurt powder

The results of functional properties of yoghurt powder are shown in Table 4.

The wettability of the yoghurt powder was 30.624sec±1.8sec. This value is comparable to those obtained by earlier workers (Koc, *et al*., 2014) [17] who concluded that the wettability yoghurt powder dried by spray drying process was 374sec. Obtained value of this study is much lower than the previous study value. Reason behind this is that there was higher temperature (50 °C) of distilled water used in this study in comparison to the past study (25 °C). Wettability of cocoa powder was better in hot water (34sec.) than cold water (19sec) (Joel, *et al*., 2013) [11]. The wettability of cow skim milk powder has been reported between 15-60s (Upadhyay, 2000) [32]. Wettability depends on the size of the particles, density of powder, charge on surface, surface area required by powder, porosity and the surface activity of the particles (Kim, *et al*., 2002) [14].

Dispersibility of the yoghurt powder was 12.402%±0.42%. There was no correlation found in between the dispersibility and solubility. But because of the water penetration, particles disperse separately in water, where they can dissolve subsequently. Dispersibility describes the ease with which the powder may be distributed, as single particle, over surface and throughout the reconstituting water. Clump formation results in dispersibility reduction (Joel, *et al*., 2013) [11]. They reported that dispersibility of cocoa powder was 18%.

The water absorption capacity of the yoghurt powder was 1.223ml/g±0.02ml/g. This value is comparable to those obtained in a study by (Zayas, 1997) [35] where it was reported that water holding capacity of milk protein powder was 0.07-0.15ml/g. Increase in granule size improves water absorption capacity.

Water absorption index and water solubility index of the yoghurt powder were found to be 1.614g/g±0.002g/g and 50.239g/100g±0.43 g/100g, respectively. Not much has been reported about water solubility index and water absorption index.

Minimum insolubility index of the yoghurt powder was 2.516g±0.04g. This value is comparable to those obtained in a study by (Pisecky, 1990) [22] where it was reported that insolubility index of instant skim milk powder should be less than 1ml. According to the Bureau of Indian Standard (IS: 1165-1967), the maximum insolubility index of skim milk powder produced by spray drying should be 2.0ml but in the current study of yoghurt powder, value obtained (2.4ml) was slight higher than this. Degree of solubility is an important parameter for powders. Food powders having lower solubility indexes result in sedimentation during reconstitution that is not desirable. Such powders create problems during processing treatments (Upadhyay, 2000) [32]. Amount of the insoluble materials in milk changes with the temperature of additional heating treatments before the drying process (Kim, *et al*., 2002) [14]. Solubility of a powder has inverse relation with the size of the particles of powders (Kurozawa, *et al*., 2009) [20].

Surface free fat of dried yoghurt was found to be 20.663%±1.13%. Value of surface free fat depends on the fat content of the food sample. Fat present in yoghurt powder gives stickiness to the surface of the powder. But it also works as a bridge between the particles of the powdered yoghurt which reduces the flowability of powder. Availability of fat globules on the surface of powder results in adherence among particles. Consequently reduces the flowability of the powder. Change in the value of flowability was observed when surface free fat was removed and reason of this change was alteration in the composition of surface (Kim, 2008) [13].

Sedimentation of the yoghurt powder was 43.833%±1.03%. This value is comparable to those obtained by earlier workers (Selamat, *et al*., 2007) [24] who reported that sedimentation value of alkalized cocoa powder was varying up to 5%. Sedimentation of particles of yoghurt powder is one of the main physical defects on the surface of the package. Yoghurt powder was insoluble, heavy and had larger particles. Addition of a suitable stabilizer is a prerequisite to form a stabilized yoghurt network.

Table 4: Result of functional properties of yoghurt powder

Parameter	Observed value
Wettability (seconds)	30.624±1.80
Dispersibility (%)	12.402±0.42
Water absorption capacity (ml/g)	1.223±0.02
Water absorption index (g/g)	1.614±0.002
Water solubility index (g/100g)	50.239±0.43
Insolubility index (g)	2.516±0.04
Surface free fat (%)	20.663±1.13
Sedimentation (%)	43.833±1.03

Values are mean ±SD, n=3

4. Conclusion and future perspectives

Properties of the yoghurt powder were assessed by the chemical, physical and functional evaluation with respect to the attributes like pH, acidity, percentage value of DPPH, bulk densities, water solubility indexes. Air drying of liquid yoghurt under optimum processing conditions(yoghurt was dried under different conditions out of which best time-temperature combination was selected for further study) was found to be produced desirable moisture content with longer shelf life. Air dried powdered yoghurt had good nutrition content. Loose bulk, packed and particle densities were 0.599g/cm^3, 0.801g/cm^3 and 0.778g/cm^3, respectively which indicated moderate porosity. Wettability was found to be moderate but cohesiveness and flowability of yoghurt powder were not of desirable quality. Reconstitution of yoghurt powder with the addition of some flavored and nutritious herbs or fruits is the future perspective of this research. Fortification of this powder as a dairy ingredient in grain products can be done to improve the textural and beneficial bacteriological property of foods.

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