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Research Article

Sorption Characteristics of *Bottle gourd burfi*

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Abstract

Bottle gourd burfi is milk and vegetable blended sweetened product popular in India. Moisture sorption characteristics of bottle gourd burfi were determined at 10°C, 25°C and 40°C. Water activity range of 0.11 to 0.97 was maintained at all three temperatures using saturated salt slurries. Static gravimetric method was used to measure equilibrium moisture content (EMC) at all the temperatures. The isotherms obtained exhibited sigmoid shape and classified as type-II. BET, GAB and Caurie models were tested to predict the moisture sorption data. %RMS and R2 values were obtained to determine precision of fit for sorption data. GAB gave the best fit for sorption data of bottle gourd burfi at all three temperatures. The Equilibrium moisture content decreased as temperature increased from 10°C to 40°C at the constant water activity. The BET monolayer value decreased from 20.15g of water/100 of solids to 13.46g of water/100g of solids, the GAB monolayer value decreased from 8.05g of water/100g of solid to 5.12g of water/100g of solid and Caurie monolayer value decreased from 5.41g of water/ 100g of solids to 3.07g of water/100g of solids when temperature increases from 10°C to 40°C. Properties of sorbed water were calculated using Caurie equation. The number of adsorbed monolayer decreased from 6.66 to 4.78, density of sorbed water decreased from 0.81 to 0.64 g/cc , bound or non-freezable water decreased from 36.13% to 14.73% and surface area of sorption decreased from 181.8 to 130.48 m2/g, as temperature increased from 10°C to 40°C. The net isosteric heat of sorption, calculated from Clausius-Clapyron equation decreased from 36.20 KJ/mol K at moisture content 21.43g of water/100g of solids to 4.12 KJ/mol K at moisture content 53.81 g of water/100g of solid. Sorption isoster for each moisture contents were also been reported.

Keywords: Bottle gourd burfi; Water Activity; Equilibrium Moisture Content (EMC); Sorption Isotherm; Net isosteric heat of sorption

Abbreviations

MSI: Moisture Sorption Isotherm; EMC: Equilibrium Moisture Content; aw: Water Activity; GAB: Guggenheim-Ander-son-de-Boer; BET: Brunauer-Emmet-Teller; SNF: Solid Not Fat; mo: Monolayer Moisture Content; C: Heat of Sorption for Monolayer; K: Heat of Sorption for Multilayer; R2: Correlation Co-efficient; %RMS: Root mean square error of model

Introduction

The traditional dairy products of an Indian subcontinent provide a profitable outlet for an organized sector [4]. Milk burfi is one of the most popular milk based sweets in India. *Burfi* is prepared by heating a mixture of concentrated milk solids (*Khoa*) and sugar to a near homogenous consistency followed by cooling and cutting into small cuboids. There are increasing trends to enhance the value of burfi by incorporating vegetable and fruits ingredients with a mixture of milk concentrate and sugar. One of the novel product is "*Bottlegourd burfi*" also known as "*Kapoorkand*".

The bottle gourd, *Lagenaria siceraria* (synonym Lagenaria vulgaris Ser.), also known as opo squash, or long melon, is a vine grown for its fruit, which can either be harvested young and used as a vegetable, or harvested mature, dried, and used as a bottle, utensil, or pipe. The fresh fruit has a light green smooth skin and a white flesh. Rounder varieties are called calabash gourds. Bottle gourd is believed to help the liver function in a balanced fashion. Because of its fiber and low fat content an Indian medicinal system *ayurveda* highly recommends this food for diabetic patients and young children. Indian traditional medicine claims that bottle gourd acts as a nerve tonic and can help improve obsessive-compulsive disorder (OCD). It was reported that the plant possesses anti-compulsive (anti-OCD) activity although they are not certain about the mechanism of action of this plant.

Therefore, when milk is supplemented with such beneficial vegetable it will provide more nutrition and marketing opportunities.

Quality of foods as received by consumers depends not only on initial composition but also on various quality changes occurring dur-ing processing, storage and distribution. Many of these changes are affected by water content and state of water in foods. Water activity is an important concept in all food products development. Rate of quality loss increases above water activity 0.2 to 0.3. Moisture Sorption Isotherm (MSI) is the relationship between equilibrium moisture content (EMC) of the material and the water activity (a_w) at a given temperature. This relationship is the key for selecting suitable packaging materials, predicting stability, drying conditions and storage of food products. MSI have been mathematically described with the help of several empirical, semi-empirical and theoretical mathematical models. Brunauer, Emmett and Teller [11] and Caurie [13] developed two-parameter equations for describing the sorption isotherms which could help in evaluating properties of sorbed water. In the "COST 90" project on water activity, Bizot [9] demonstrated that the 'Guggenheim-Anderson-de Boer' (GAB) equation was the three parameter theoretical model giving best fit for most food isotherms over a wide water activity range and also provides a better evaluation of the amount of water tightly bound by primary adsorption sites. Fur-thermore, the knowledge of temperature dependence of sorption phenomenon provides useful information on the energetic of water sorption process in foods [31].

Moisture Sorpion Isotherm of several food products including whey protein, casein, lactose, whey powder, milk powder, cheese and yogurt have been established but the published report on Indigenous dairy products are scarce. Moisture sorption is the fundamental phenomenon in every food products. However, meager attempts have been made for development of scientific data and to address the shelf-life and packaging problems in Indian milk based food products. Information on moisture sorption isotherms of indigenous dairy products including *dudh churpi* [17], chhana powder and casein [6], sandesh powder and shrikhand [21,22], *lal peda* [5], etc., have been reported. For product and process up gradation of bottle gourd burfi the data on moisture sorption characteristics was needed to estab-lish. Therefore, studies were carried out to establish sorption characteristics of bottle gourd burfi.

Materials and Methods

Preparation of bottle gourd burfi

Bottle gourd burfi was prepared as per the standard method reported by Gupta., *et al.* [15]. Fresh buffalo milk obtained from local market was standardized to 5 percent fat and 9 percent SNF and boiled in a shallow pan by placing over a brisk and non smoky fire. Milk was stirred and scrapped continuously with a ladle till it reaches one third of its initial volume. Fresh bottle gourd selected (9-10 inches in diameter of *Lagenaria Siceraria* family) washed, peeled, cut into small pieces and finally grounded to smooth paste previously, prepared was added and mixed with hot milk concentrate. When whole mass reduced to half of the initial volume, sugar at the rate of 12% was added and mixed thoroughly. When dough like stage was reached, contents were set in a greasy tray and allowed to cool and cut into required size and shapes.

Determination of sorption isotherm

To determine the moisture sorption isotherm of bottle gourd burfi, sorption devise as recommend by Labuza (1968) [24] was used for equilibration studies. The sorption apparatus consisted of airtight wide mouth jar in which sample was kept in a sample container placed on the tripod exposed to the humid atmosphere in a temperature controlled chamber. Each container kept for sorption study represents specific relative humidity. For temperature control, the sorption containers in triplicate measures were placed in thermo regulated chamber maintained at 10°C, 25°C and 40°C. To equilibrate the sample with each relative humidity reagent grade salt solutions as recommended by Greenspan [16] viz., lithium chloride (LiCl), potassium acetate (CH_3COOK), magnesium chloride ($MgCl_2$), potassium carbonate (K_2CO_3), magnesium nitrate ($MgNO_3$), sodium chloride (NaCl), ammonium sulfate ((NH4) $2SO_4$), potassium chloride (KCl), potassium nitrite (KNO_3) and potassium sulfate (K_2SO_4) were used to obtain water activities values from 0.11-0.97. Extra pure salts were dissolved in distilled water initially heated to 100°C and cooled to each test temperature to form a saturated slush. The level of saturated salt solution (slush) was kept in the bottom of each jar to a depth of about 0.4 cm. After taking the tare weight of sample container approximately 2g of freshly made homogenous sample of bottle gourd burfi weighed into sample container. To prevent mould growth approximately 5 mg potassium sorbet was added to each sample. At each water activity and temperature maintained, the equilibrium was carried out. The weights were recorded at regular intervals (after every 72 hrs) and equilibrium was judged to have been attained when difference between three consecutive weighing did not exceed 1 mg. Equilibrium period last for two to three week.

Compositional Analysis

Compositional analysis of the bottle gourd burfi (Table 1) was done as per the AOAC methods [36] and BIS: SP: 18 (Part XI)-1981 [8] for moisture, fat, protein, total sugars acidity and ash content. The proximate composition of bottle gourd burfi is mentioned in table 1.

Parameters	Percentage
Moisture	33.92
Fat	10.30
Protein	8.91
Lactose	7.41
Sucrose	35.65
Acidity	0.25
Dietary Fibre	0.15
Ash	1.4

Table 1: Proximate composition of bottle gourd burfi.

Mathematical models and calculations

The BET, GAB and Caurie models were chosen to fit an experimental sorption data for bottle gourd burfi. BET equation is a funda-mental milestone in determining the multi-layer sorption isotherms. It is useful for determining the optimum moisture condition for storage stability of dehydrated food products. However, as reported BET relationship is valid up to a_w=0.55

aw / (1-aw)m =1/moC + (C-1/ moC) aw (i)

Where, 'm' is the moisture content (db), aw is the water activity, mo is the BET monolayer moisture content, and C is a surface heat constant. GAB model is widely accepted as most useful for characterizing the isotherms over the entire aw range (0-0.9). The co-efficient of GAB have theoretical physical meaning such as providing monolayer moisture content. The GAB parameters were calculated by fitting moisture sorption isotherm water activity and moisture data to a 2nd degree polynomial.

m = mo kb aw/[(1 - kb aw)(1 - kb aw + kb Caw)] (ii)

Where, kb is a multilayer factor.

Caurie equation is an improvement in BET equation and can also be used to calculate properties of sorbed water.

ln 1/W = - ln 1/ CW0 + 2C/ W0 ln [1 – aw/ aw] (iii)

Where, W is moisture content in kg water/kg dry solid, Wo is moisture content corresponding to saturation of all primary adsorption sites by one water molecule (equivalent to monolayer in BET theory) and C is density of sorbed water. Caurie's plot of (1 - aw/ aw) vs. ln 1/W over the aw range was used to obtain Caurie's slope.

Properties of Sorbed water

The number of adsorbed monolayers was obtained by the formulae [13]:

S = 2/N (iv)

Percent bound water or non freezable water is the product of monolayer value Wo in the equation and number of adsorbed monolayer [18].

The surface area of adsorption 'A' was determined by the formula [18]:

A = 5454/S (v)

Net isosteric heat of sorption

The net isosteric heat of sorption (qst) provides information on amount of heat required to be removed in excess of latent heat of vaporization of pure water, for extracting the sorbed water at a particular moisture content. It can be evaluated at different moisture content using best fitted isotherm mode as sorption data are obtained at different temperatures. The Net isosteric heat of sorption was determined using Clausius-Clapeyron equation [25]:

$[\partial \ln aw / \partial 1 / T]M = Qst / R$ (vi)

Where,
Qnst is the isosteric sorption heat (kJ/mol), R is the gas constant (0.00831434 kJ/mol K) and T is the absolute temperature (K).

Slope of plot of ln(aw) versus 1/T at constant M gave the net isosteric heat of sorption.

In order to ascertain the precision of fit of the sorption data in the sorption models tested the coefficient of regression (R^2) and root mean square (%RMS) of error of models were calculated from the equations below:

$R^2 = \sum^n_i=1 (xi – xi\hat{})2 / (xi – x\text{-})^2$ (vii)
% RMS= SQRT $1/n \sum ni=1 (xi – xi\hat{} / xi)^2 *100$ (vii)

Where, '*n*' is the number of observations 'xi' is the experimental value, 'xi^' is the value obtained by the fitting model for the ith ob-servation, 'x-' is an absolute mean.

Results and Discussion

Moisture sorption phenomenon

Moisture Sorption Isotherm is the relationship between equilibrium moisture content of the material and the water activity at a given temperature. This relationship is the key for selecting suitable packaging materials, predicting stability, drying conditions and storage of foods.

The moisture sorption isotherm of bottle gourd burfi was determined at the temperatures of 10°C, 25°C and 40°C within the water activity range of 0.11-0.97. The moisture sorption isotherms were plotted between moisture content of the sample and the water activi-ties at a constant temperature. The resultant isotherm plots are presented in figure 1 to 3. Each data point is an average of three mea-surements. The plots obtained at different temperature were sigmoid in shape and corresponds to type II as per the classification given by Brunauer., *et al.* [12]. According to Bolin [10] and Bandyopadhyay., et al. [6] type-II isotherms are typical of foods high in carbohy-drates. Moisture sorption characteristics reported for many other food products typically shows the similar behaviour [6,21,22,32,33].

In Bottle gourd burfi two bends are identified in each curve presented in figure 1 to 3. In figure 1 first bend was noted at 0.33 aw and another around 0.86 aw which divides the curve in three regions, region-I in 0.11-0.33 aw range, region-II in 0.33-0.86 and region-III in 0.86-0.97 aw range. Similarly, in figure 2 region-I was obtained in the aw range of 0.11-0.24, region-II in 0.24-0.33 and region-III in 0.33-0.97 aw range. At 40°C (figure 3) region-I, II, and III were noted in 0.11-0.24, 0.24-0.43 and 0.43-0.97 aw range respectively. According to Rahman [27] region-I considered as monomolecular region (aw<0.05>0.234) in which single layer of water is formed around the food which is strongly adsorbed on individual polar groups of substance by an ionic and vander waals forces. Region-II indicates mul-timolecular region (aw< 0.234>0.757). In this region more than one layer of water is bonded to food by hydrogen bonds. In this region, chemical and biochemical reactions requiring solvent water starts to take place because of increased mobility of solution. Region III is considered as capillary condensation region (aw <0.76>0.9) water molecules condense on porous structure of food [3]. Water in this region is in Free State. The EMC increases gradually with the increase in water activities at all the temperatures. At 10°C as aw increased from 0.11-0.97 EMC also increased from 0.09% to 0.68%. Similarly at 25°C the EMC increased from 0.12% to 1.43% and at 40°C EMC increased from 0.02% to 1.38%.

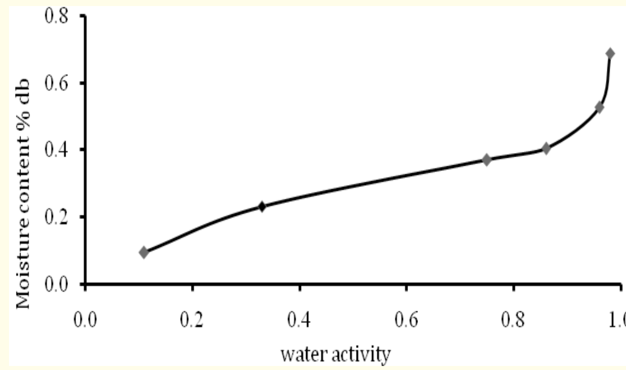

Figure 1: Moisture sorption isotherm of bottle gourd burfi at 10°C.

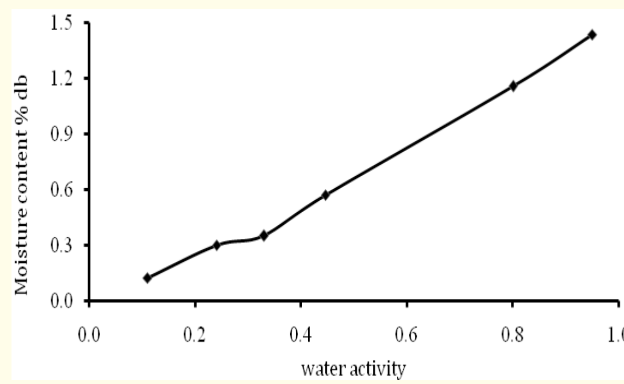

Figure 2: Moisture sorption isotherm of botte gourd burfi at 25°C.

Effect of Temperature on sorption isotherm of bottle gourd burfi

The effect of temperature on sorption isotherm of bottle gourd burfi was studied. The EMC was decreased as temperature increased at all water activities in bottle gourd burfi. The Equilibrium moisture content decreased from 0.09g of water/g solids to 0.02g of water/g solids as temperature increased from 10°C to 40°C at the constant water activity of 0.11. This indicates that the Bottle gourd burfi is less hygroscopic in nature. This may be due to less availability of starch in bottle gourd burfi. Similar observations reported Lavoyer., et al. for green coconut pulp [26]. A rise in temperature causes an increase in water activity to keep same moisture content level. The kinetic energy of water molecule is high and water adsorption is low at high temperature [34]. The carbohydrates and proteins are known to have high water binding capacity at low temperature and Bottle gourd burfi is a good source of protein and carbohydrates. Therefore reductions in water binding capacity at 25°C and 40°C as compared to 10°C could be due to the high protein and carbohydrate contents of Bottle gourd burfi. The increase in water activity with the temperature shows that the sorption in Bottle gourd burfi is an exothermic process i.e., a reaction that releases energy in the form of heat. Similar observation was reported by Khojare for shrikhand [22].

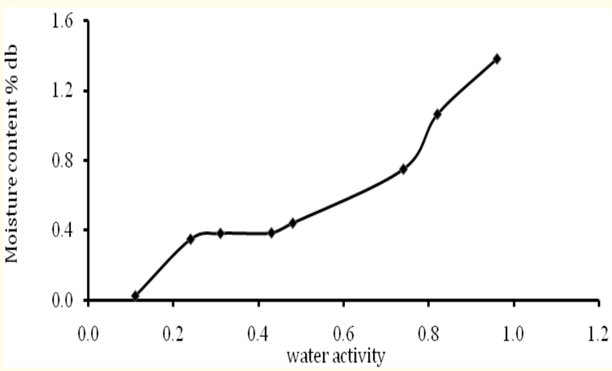

Figure 3: Moisture sorption isotherm of bottle gourd burfi at 40°C.

Several researchers have observed an increase in aw with an increase in temperature [5,20,2128]. As the temperature increases, the structure and constituents of the materials were affected resulting in reduction in sorption sites and decrease in EMC. At high stor-age temperatures there would be a shift in aw to the values above the critical level for the storage of product even though the EMC is constant. Hence the product could deteriorate at the higher temperatures than it would at the lower temperatures even when the EMC remains constant [2].

Modelling of sorption isotherms

A large number of sorption models have been proposed to determine sorption isotherms [7,9-13]. For Bottle gourd burfi BET, GAB and Caurie models were tested to predict the moisture sorption data and to establish the sorption behaviour of the product. The result of fitting moisture sorption data to the sorption models shown in table 2 to 4. The BET, GAB and Caurie models appeared to be the most suitable to describe the sorption relationship in bottle gourd burfi. The GAB model emerges as the best model and is widely used for foods with high sugar content [14]. The total sugar in bottle gourd burfi was 43.06%.

Temperature (°C)	m_0 g water/ 100g solids	C	R^2	% RMS
10	20.15	-20.76	0.80	18.36
25	15.13	-8.59	0.86	0.31
40	13.46	-5.58	0.95	7.48

Table 2: Estimated parameters of BET isotherm equation fitted to sorption data of bottle gourd burfi at different temperatures.

Temperature (°C)	m_0 g water/ 100g solids	K	C	R^2	% RMS
10	8.05	0.88	-4.85	0.92	11.37
25	7.02	1.29	10.32	0.92	5.91
40	5.12	1.79	-1.14	0.97	3.51

Table 3: Estimated parameters of GAB equation fitted to sorption data of bottle gourd burfi at different temperatures.

From table 2 it can be noted that the BET equation showed relatively good fit at 10°C, 25°C and 40°C as regression co-efficient (R2) and %RMS obtained as 0.80. 0.86, 0.95 and 18.36, 0.31, 7.48% respectively. BET usually shows best fit to aw <0.55. In spite of the theoretical limitations of the BET adsorption analysis, the BET monolayer concept is a reasonably correct guide with respect to various aspects of interest in dried foods. This indicates that the BET model is relatively good fit for predicting moisture sorption behaviour of Bottle gourd burfi.

The GAB equation for a instance was fitted to sorption data at 10°C, 25°C and 40°C and regression coefficient obtained as 0.92, 0.92 and 0.97 respectively. The values of % RMS values obtained for GAB equation were 11.37, 5.91 and 3.51% at 10°C, 25°C and 40°C respectively. This indicates that the GAB equation is the best fit for the sorption data of for bottle gourd burfi. The value of K provides a measure of interactions between the molecules in the multilayer with the adsorbent, and it tends to fall between the energy value of the molecules in the monolayer and that of free water [26]. In the present study, the K value increased from 0.889 to 1.793 as the temperature increased from 10°C to 40°C. These results are in agreement with Kumar and Mishra [23] for mango-soy-fortified yoghurt powder.

The Caurie equation was fitted to sorption data in the aw range of 0.11-0.97 at 10°C, 25°C and 40°C and regression coefficient ob-tained as 0.93, 0.92 and 0.93 respectively The values for %RMS obtained at 10°C, 25°C and 40°C were 15.95, 13.19 and 4.06% respec-tively. The values get scattered beyond these water activity range. Prediction of water sorption is required to establish water activity and water content relationship for materials.

Temperature (°C)	m0 g water/ 100g solids	Curie's slope	Density of sorbed Water (g/cc)	No. of adsorbed monolayers	Bound or non freezable water (%)	Surface area of sorption (m^2/g)	R^2	% RMS
10	5.41	0.3	0.81	6.66	36.13	181.8	0.93	15.9
25	3.09	0.3	0.61	5.03	15.57	137.3	0.92	13.1
40	3.07	0.4	0.64	4.78	14.73	130.4	0.93	4.06

Table 4: Properties of sorbed water in bottle gourd burfi at different temperature.

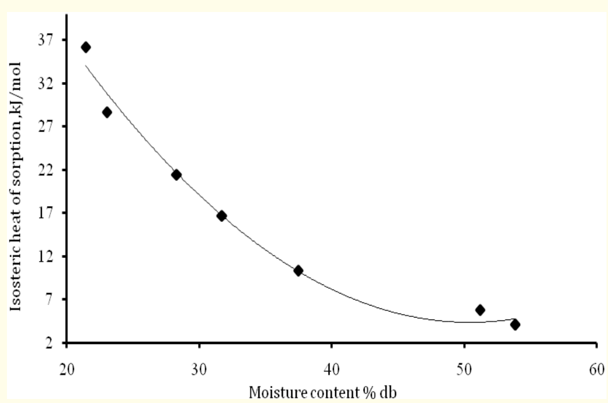

Figure 4: Net isosteric heat of sorption of bottle gourd burfi with moisture content.

Monolayer Moisture Content

The monolayer moisture content was calculated from BET, GAB and Caurie equation and presented in table 2 to 4. The monolayer concentration has been considered to represent the optimum moisture content for the conservation of food products. The monolayer moisture content is defined as the amount of water capable of interacting with all the available adsorption sites in a material. However, at moisture content close to the monolayer concentration, not all of water present is part of monolayer. A quantity remains in more mobile state is thought to be responsible for maintaining the equilibrium vapour pressure for an environment. The BET m0 decreased from 20.15g of water/100g of solids at 10°C to 15.13g of water/100g of solids at 25°C and finally decreased to 13.46g of water/100g of solid at 40°C. Kaymak-Ertekin and Gedil [19] reported the m0 calculated by BET model for an apple as 13.7g of water/100 g of solid. Alakali and Satimehen [2] reported the m0 for peeled ginger Powder up to 12.12g water/100g solid and unpeeled ginger powder up to 18.51g water/100g solids. Rangel-Marron., *et al.* [30] reported BET m0 for freeze dried mango pulp as 0.1597, 0.1358 and 0.1284 kg water/kg dry solids. The GAB m0 obtained presented in table 3 shows decreasing trend from 8.05g of water /100g of solid at 10°C to 7.02g of water /100g of solids at 25°C and further reduced to 5.12g of water /100g of solids at 40°C. Similar observations have been reported by Park., et al. [28] for pear as 7.2g of water/100g of solids and Vega., et al. [35] for corn flour as 8.2g of water/100g of solids. The m0 calculated from Caurie equation for Bottle gourd burfi is shown in table 4. The m0 decreased from 5.41g of water/100g of solid at 10°C to 3.09g of water/100g of solids at 25°C and further decreased to 3.07g of water/100g of solids at 40°C. Bandyopadhyay., et al. [6] reported the Caurie m0 as 6.3%, 4.0% and 5.2% for casein, lactose and chhana powder respectively. The effect of temperature on monolayer moisture content is important in dehydration, shelf-life monitoring and storage studies.

Properties of sorbed water

Caurie equation was used to estimate the properties of sorbed water at 10°C, 25°C and 40°C and presented in table 4. The property of sorbed water is useful to understand the behaviour of the moisture at different temperature and subsequent shelf life determination. The important properties of sorbed water includes density of sorbed water, number of absorbed monolayer, bound or non-frezeeble water and surface area of sorption. The bound or non-freezable water decreased from 36.13 percent at 10°C to 15.57 percent at 25°C and further reduced to 14.73 percent at 40°C. The density of sorbed water decreased from 0.81g/cc at 10°C to 0.61g/cc at 25°C. How-ever, it was further increased from 0.61 to 0.64 g/cc at 40°C. This may be due to varying impact of temperature on different ingredients in the bottle gourd burfi. Prateek Sarma [29] represented the sorption isotherm and thermodynamics of water sorption of ready-to-use Basundi mix and concluded that the enthalpy-entropy compensation shows that sorption mechanism involved is enthalpy driven over entire range of moisture content studied.

The surface area of sorption decreased from 181.8 m2/g at 10°C to 137.38 m2/g at 25°C further decrease to 130.48 m2/g at 40°C. The surface area of a product is influenced by an increase in temperature. The number of adsorbed monolayer decrease from 6.86 to 4.78 with an increase in temperature from 10°C at 40°C.

Net Isosteric Heat of Sorption

The net isosteric heat of sorption is the difference of total heat of sorption (qst) and heat of vaporization of pure water, gives the energy requirement for removing the moisture from the food materials (water-solid binding strength), has a practical use in complete drying calculations and modelling of energy requirement [7]. The knowledge of the dependence of heat of sorption of water on mois-ture content can be used to estimate the energy needed in the drying procedure and provides important data on behaviour of water in food products [26].

The net isosteric heat of sorption of Bottle gourd burfi as a function of EMC was calculated using Claisius-Clapeyron equation at 10°C and 40°C. Figure 5 shows sorption isosters wherein ln (aw) was plotted against an inverse of temperature for each moisture con-tent. For Bottle gourd burfi the net isosteric heat of sorption was plotted against moisture content and presented in figure 4. The net isosteric heat of sorption decreased from 36.20 KJ/mol K at moisture content 21.43g of water/100g of solids to 4.12 KJ/mol K at mois-ture content 53.81g of water/100g of solids which shows that the low moisture removal requires high amount of heat as compared to high moisture content which can be evaporated using less heat. Almost similar behaviour also been reported by Al-Muhtaseb., *et al.* [1] who studied the water sorption and thermodynamic properties of starch powder. Kiranoudis., *et al*. [20] reported the maximum value of net isosteric heat of sorption falling from 34.80 KJ/mol K at moisture content 6g of water/100g of solids to 7.30 KJ/mol K at moisture content 20g of water/100g of solids for potatoes. It can also be attributed from fig 4 that the net isosteric heat of sorption is high for low moisture content indicates a strong link between the adsorbate (water) and the adsorbent. The decrease in net isosteric heat of sorption with increase in moisture content could be explained quantitatively as adsorption occurs initially at most active sites involving high energies of interaction and as these active sites become occupied, the adsorption subsequently occurs on less active site involving lower interaction energies [2]. Similar behaviour was reported by Sawhney., *et al*. for khoa [33] and Rao., *et al.* for chhana podo [18].

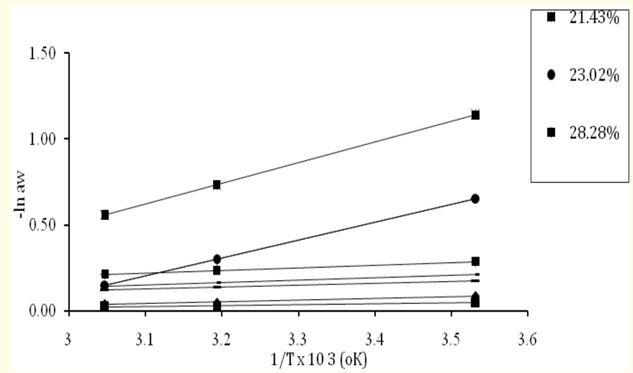

Figure 5: Sorption isosters of bottle gourd burfi at different moisture content.

Conclusion

Moisture Sorption Isotherm of bottle gourd burfi was determined at 10°C, 25°C and 40°C. The curves obtained exhibit sigmoid shape and described as type II. The EMC values of bottle gourd burfi increased with increase in water activity and decreased with in-creasing temperature. Three models viz., BET, GAB and Caurie were tested over water activity range of 0.11-0.97. The GAB model was found as best fit for experimental sorption data in botlle gourd burfi. The monolayer values obtained from GAB, BET and Caurie equa-tion decreased with increasing temperature. Caurie equation was used to determine the properties of sorbed water in bottle gourd burfi. The net isosteric heat of sorption decreased from 36.20 KJ/mol K to 4.12 KJ/mol K with increasing moisture content which shows that lower moisture removal requires high amount of heat. Moisture sorption data generated for bottle gourd burfi will be useful for selection of packaging material, drying conditions and process up gradation for bottle gourd burfi. The future work on shelf life model-ling of this product may be carried out.

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