Biological Forum – An International Journal 16(9): 117-123(2024)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Hydration Behavior and Process Modeling of Dried Green Peas (KPS 10)

Suresh Chandra* and Anuj Choudhary
Department of Agricultural Engineering, SVPUAT, Meerut (Uttar Pradesh), India.

(Corresponding author: Suresh Chandra)*
(Received: 21 June 2024; Revised: 26 July 2024; Accepted: 10 August 2024; Published: 14 September 2024)
(Published by Research Trend)

ABSTRACT: Moisture diffusion in Pea (KPS 10) during soaking in water at different temperatures *viz*., ambient temperature and 60°C was studied. Before soaking of green dried pea, the green peas were dried by sun drying, solar drying and tray drying (at 50, 60 and 70°C temperature). The final moisture content of dried green pea by different methods was considered as initial moisture content for further soaking studies. The initial moisture content (dry basis) of pea (KPS-10) was obtained for SD (24.08 %), SLD (14.40 %), TD_{50C} (16.69%), TD_{60C} (8.07%), and TD_{70C} (7.09 %). Model tested for hydration behaviour are Newton/Lewis and Peleg's equations for soaking of dried green peas at ambient temperature and 60°C for period of 3.5 h in water. The data were used to determine model parameters. The goodness of fit for models were evaluated by highest value of coefficient of determination (R^2). The weight of dried green pea during soaking process was determined in terms of moisture content (dry basis). The resulting kinetic data were correlated by means of different modeling equations. Peleg model predicted adequately the hydration kinetics of dried green peas (KPS-10) under given condition. The Peleg model rate constant K_1 and Peleg constant capacity K_2 were affected by the increasing soaking time and drying methods. Among the both models, Peleg model was found to be most suitable for describing the hydration behavior of green dried peas by drying methods, temperature and soaking time.

Keywords: Dried green pea, hydration ratio, hydration rate, soaking temperature, soaking time.

INTRODUCTION

Peas have long been a staple of the human diet due to its excellent nutritional value, low fat, high fiber content, low cholesterol, and high digestible protein content (7.2 g/100 g), carbohydrates (15.8 g), vitamin C (9 mg), phosphorus (139 mg), and minerals. Typically, the fruit is a pod with four to nine seeds within. Pods are inflated and range in length from 5 to 9 cm, however they are only available in the winter. During the winter, green peas are only accessible for around five months. The majority of foods that are generally referred to as peas are actually dried peas, such mature pods' shelled peas. Green or immature peas are used as a vegetable and come in canned, frozen, or fresh form. They are used to prepare a variety of snacks as well as to make veggies and give flavor to some vegetables. However, green peas have a maximum shelf life of three to four days. India ranks fifth on the list of major pea growers, behind France, and is among the world's top producers of the crop. With a manufacturing capacity of 7.8 lakh tonnes, India makes up around 7% of global produce. The states of Uttar Pradesh, Madhya Pradesh, Himachal Pradesh, Jharkhand, Punjab, Haryana, and Uttarakhand are the primary growing regions for peas in India.

The best way to dry peas without much quality deterioration is to use pre-drying treatments followed by mechanical dehydration. As a result, dried peas can be used in a wide range of food products, including purees, muffins, cakes, soup mixes, breakfast cereals, baked goods, confections, and dairy products. This way, dried peas can be used all year round. By lowering the weight and volume of the finished product's nutritional value and taste, drying also reduces the cost of packaging, storing, and shipping in addition to preserving food (Chauhan and Srivastava 2009).

One of the most popular methods for process design and optimization is mathematical modeling. Because mathematical models are straightforward and simple to use, they predominate in the field even with the availability of numerous sophisticated statistical tools and programming languages (Sopade *et al.,* 1992, 2007). The hydration behavior of leguminous seeds and cereal grains, including cowpea, kidney beans, foxtail millet, rice, maize, sorghum, and wheat, has been the subject of numerous studies (Peleg, 1988; Abu-Ghannam and McKenna 1997; Taiwo *et al*., 1998; Jideani and Mpotokwana, 2009; Kashiri *et al*., 2010; Vasudeva *et al*., 2010). Similar to this, a number of mathematical models, such as the Peleg, Henderson, and Pabis, exponential, Page, two-term exponential, and modified Page models, have been devised to describe the hydration kinetics of food items (Becker, 1960; Hsu, 1983a,b; YiZang *et al*., 1984; Singh and Kulshrestha 1987; Peleg, 1988; Kashaninejad *et al*., 2007). In contrast, the Peleg's model—also referred to as Peleg's equation—is essentially a two-parameter, non-exponential empirical equation that was developed to simulate the behaviors of food materials' absorption of water (Peleg, 1988). The principal features of this equation lie in its simplicity when compared to other equations, it is applicable to the curvilinear segment of the sorption curve (Vasudeva *et al*., 2010) and most of its applications were carried out at constant soaking temperatures (Peleg, 1988; Abu-Ghannam and McKenna 1997; Taiwo *et al*., 1998; Shittu *et al*., 2004; Jideani and Mpotokwana 2009; Vasudeva *et al*., 2010). Determining the hydration kinetics of each food material that will be subjected to soaking unit operation during processing is important because it allows one to predict the soaking time under specific conditions and understand how processing variables like temperature will affect the material (Verma and Prasad 1999). Thus, the quantitative information typically produced by hydration experiments is helpful for real-world uses such as soaking condition characterization and optimization, food processing equipment design, and water absorption prediction as a function of temperature and time (Bhattacharya, 1995; Abu-Ghannam and McKenna 1997; Taiwo *et al.,* 1998; Addo and Bart-Plange 2009).

Consequently, the main goals of this study are to create regression equations that accurately represent the hydration behavior of dried green peas (KPS 10) under each of these conventional soaking conditions and to investigate the applicability of the Newton & Leweis and Peleg model/equation to the hydration behavior of the peas with regard to each of these conventional methods despite the fact that the soaking temperatures are not constant.

MATERIALS AND METHODS

Studies on the hydration kinetics and physical characteristics of green peas (KPS 10) were carried out through experiments. Food Analysis Laboratory and Process and Food Technology, S.V.P. University of Agriculture and Technology, Meerut, were the study's locations. Research was done to assess the physical characteristics of green pea and how well they dehydrated using a variety of drying techniques, *i.e.,* sun, solar, and tray drying (at 50°, 60° and 70°C), as well as to calculate the hydration kinetics of dried green pea. For this investigation, the raw materials—green peas (KPS 10 and Pahuja 4400)—were sourced from the Saharanpur local market. Improved variety KPS 10 was generated by Kalash Seeds Private Limited and used for research purposes. These seeds are resilient against diseases, have a lengthy pod size with 8–10 seeds per pod, mature early—picking can be done 75 days after sowing. To get rid of any foreign material, the green peas were carefully cleaned. Prior to testing, peas were kept in a cool, dry location at room temperature. Samples of green peas were dried using three different techniques, and the hydration kinetics were then studied at room temperature and at 60°C.

Moisture content: Using a hot air oven set at 105°C and weighing 5 g of sample, the moisture content of dried green pea samples was determined using the AOAC (2000) method. The sample was then left in the oven for 8 to 10 hours. A product's moisture content is often reported as a percentage and is determined by the weight of water it contains. Moisture content (%) is designated by two methods, Wet basis (wb) and dry basis (db).

$$\text{Moisture content }(\%) = \frac{W_i - W_f}{W_i} \times 100 \qquad 1$$

W_i = Initial weight of dried green pea taken, g

W_f = final weight of dried green pea after oven drying, g

Experimental Procedure: An aluminum container was used to carry out the soaking test. The water bath's continuous temperature was raised by one to two degrees Celsius over the necessary soaking temperature. 50 g samples of dried green pea grain were soaked in screw-tap flasks holding 200 mL of distilled water to measure the grain's water uptake. Study temperatures for soaking were 40°C, 50°C, and 60°C. Prior to conducting hydration studies, the water-filled flasks were allowed to establish thermal equilibrium for a few hours in a thermostatically controlled oven that was set at the necessary soaking temperature. Subsequently, the experiment was initiated by filling the screw-tap flasks with grains. These were put in a stirred water bath with a constant temperature that was maintained within 0.5°C of the testing temperature. The flasks were taken out of the bath at regular intervals to measure the moisture content. After the grains were soaked, they were weighed with an accuracy of ±0.1 mg and filtered through an 80-mesh sieve to eliminate surface water. This procedure was established based on the preliminary test results and other previous studies (Abu-Ghannam and McKenna 1997; Haros *et al.,* 1995; Muthukumarappan and Gunasekaran, 1991). Then, the grains were placed in an oven for moisture content determination (AOAC, 2000; Vengaiah *et al.,* 2012).

Hydration kinetics of Pea (KPS 10): To ascertain the hydration behavior of the pre-dried pea, it was soaked in a water bath at room temperature and 60°C while exposed to atmospheric conditions. For the soaking experiment, a water bath with a consistent temperature was utilized. It was composed of a water holding chamber, an immersion heating coil, and a thermostat to regulate the water's temperature. The knob can be turned to get the desired temperature. Hydration rate was calculated using following equation

$$\text{Hydration rate} = \frac{\text{amount of average water absorbed (g)}}{\text{Time interval (h)} \times \text{bone dry weight of sample(g)}} \qquad 2$$

Mathematical Model for hydration: Moisture content (g water/g dry solid) of the sample (M) is calculated by the following equation (3) and recommended by Naderinzhad (2016).

$$\text{Moisture content (g water/g of dry solid)} = \left(\frac{\text{Mt}-\text{Md}}{M_{\text{d}}}\right) \qquad (3)$$

where M_t is the mass of sample at time *t* and M_d is mass of dry solid. Due to the inherent and natural variations in the samples' initial moisture content, the moisture content must be the same for every sample in the base measure. Therefore, the moisture ratio (MR) expression is calculated using the following equation:

$$MR = \frac{M_t - M_e}{M_0 - M_e} \qquad (4)$$

where M_t, M_e, and M_0 are moisture content at any time, equilibrium moisture content, and initial moisture content, respectively. Using this procedure, samples were kept in a constant temperature and relative humidity condition. The moisture content of the samples was measured and used as the equilibrium moisture content (Me) when the change in sample weight was negligible. In order to low humidity in ambient (dry and hot weather), equilibrium moisture content is negligible and

$$MR = \frac{M_t}{M_0} \tag{5}$$

Hydration curves were constructed by MR versus time. Hydration rate is proportional to the numerical differentiation of hydration curves. Throughout the study, this idea is employed as the dimensionless hydration rate (HR).

Models of hydration kinetics do not account for interactions caused by factors other than drying time. Lewis (1921) first proposed the idea of using thin-layer drying models to describe the drying behavior. Lewis developed a semi-theoretical model for porous hygroscopic materials, which is comparable to Newton's law of cooling. The following model was developed and used for hydration kinetics of pea.

$$\frac{M_t - M_e}{M_0 - M_e} = \exp(-kt) \tag{6}$$

where MR is moisture ratio, k is hydration constant (m^{-1}), t is soaking time, M_t, M_e, M_o is moisture content at any time, equilibrium and initial, respectively. For the Newton model, the semi-logarithmic plot of the moisture ratio and soaking time shows a straight line. Peleg (1988) put forth a two-parameter sorption equation and examined the prediction accuracy of the equation during the soaking and water vapour absorption of whole rice and milk powder. This equation has since been known as Peleg model (Eq. 7)

$$M = M_0 \pm \frac{t}{K_1 + K_2 t} \tag{7}$$

Where M is moisture content (db %) at time (t), M_0 is Initial moisture content (db %), K_1 is the Peleg rate constant (h db%$^{-}$), and K_2 is the Peleg capacity constant (db %$^{-1}$). In equation (9), “±" becomes “+” if the process is absorption or adsorption and “- ” if the process is drying or desorption.

This equation is usually written in rather simple way for water absorption to test its ability to fit experimental curve (Eq. 8):

$$\frac{t}{M - M_0} = K_1 + K_2 t \tag{8}$$

According to Eq. (8), a plot of $t/(M - M_0)$ against soaking time (h) gives a straight line, where K_1 is the intercept on the ordinate and K_2 is the slope of the line. The values of K_1 and K_2 were calculated by linear regression by using MS Excel software.

The sorption mechanisms in a variety of foods have been described using the Peleg model. The water absorption of dasheen been leaves has been studied using the model (Maharaj and Sankat 2000). The water absorption behavior of green gram during soaking was modeled using Peleg's equation (Foke and Kulkarni 2018). Once more, the goal was to investigate how much water the chickpeas absorbed during soaking (Turhan *et al.,* 2002).

RESULTS AND DISCUSSION

The hydration behviour of varieties of dried green peas (KPS-10) was evaluated. Investigation was carried out to see the hydration kinetics properties of dried green pea like hydration time, hydration rate and hydration ratio along with application various models.

Hydration behavior of dried green pea (KPS-10): The final moisture content of dried green pea by different methods was considered as initial moisture content for further soaking studies. The initial moisture content (dry basis) of pea (KPS-10) was obtained for SD (24.08 %), SLD (14.40 %), TD_{50C} (16.69%), TD_{60C} (8.07%), and TD_{70C} (7.09 %). A relationship between soaking time and moisture content is shown in (Fig 1). After hydration, final moisture content (on dry basis) of the peas (KPS-10) was observed for SD (197.77 % & 234.99%), SLD (175.74% & 210.07 %), TD_{50C} (183.55% & 217.36%), TD_{60C} (163.78% & 195.14 %), and TD_{70C} (162.31 % & 193.36%) at ambient and 60° temperatures, respectively. The moisture content of the peas increased with increasing soaking time (Table 1). The result indicates that the soaking time was increased the moisture content of the peas also increased, similar trends was found at 60°C temperature of soaking of dried green peas. Water accumulated in the free capillary and intermuscular spaces of the grains during the soaking process, which may have contributed to the gradual decrease in the water penetration rate into the grains (Abu-Ghannam and Mckenna 1997).

Table 1: Moisture content (%, db) of dried green pea during soaking at Ambient and 60°C temperature.

Time (h)	Ambient Temperature					60°C Temperature				
	SD	SLD	TD_{50C}	TD_{60C}	TD_{70C}	SD	SLD	TD_{50C}	TD_{60C}	TD_{70C}
0	24.08	14.40	16.69	8.07	7.09	24.08	14.40	16.69	8.07	7.09
0.5	117.12	101.37	107.70	92.43	90.58	92.31	78.49	84.36	70.81	70.24
1.0	143.18	121.97	134.54	114.05	116.27	141.94	125.40	131.04	114.05	111.99
1.5	169.23	140.27	148.54	131.35	132.33	172.95	152.86	159.04	141.08	137.69
2.0	178.83	152.86	162.54	141.08	141.97	191.56	172.31	177.71	159.46	156.96
2.5	185.77	162.01	171.88	149.73	151.61	210.17	188.33	196.38	175.68	174.09
3.0	191.98	170.02	177.71	157.30	158.03	222.58	200.92	208.05	187.57	189.08
3.5	197.77	175.74	183.55	163.78	162.31	234.99	210.07	217.39	195.14	193.36

The hydration rate of dried green peas was increased initially, thereafter decreased with increasing the soaking time. At the soaking time (0.5 h or 30 min), hydration rate was found highest followed by decreased gradually during soaking upto 3.5h. The hydration behavior isshown between soaking time and hydration rate in Table 2. The highest hydration rate was found sundried green peas and thereafter rehydrated at ambient temperature while lowest in tray tried green pea at 60°C temperature and soaked at 60°C temperature in water for 3.5 h. From the Table 2, it indicated that hydration rate is found at ambient temperature as compared 60°C temperature of soaking. This might be due to overall result indicate that the hydration rate was decreased as the moisture content of the dried green peas increased during soaking time. This might be due to the grain absorbed moisture during its initial time and its water absorptivity also increase. Similar result was reported by (Mohanty *et al.,* 2002; Verma and Prasad 1999). The study reveals that the rate of water absorption of green dried peas at the beginning was higher, but when the soaking time increased, the green dried peas reached its maximum water content at a certain soaking time.At initial stage of soaking, higher the water absorption so that higher the hydration rate of green dried peas was indicated at both temperatures. The result of the study revealed that higher temperature of soaking of dried green adversely affect the rate absorption of water. It may be due to drying makes hardening the tissues of green peas.

Table 2: Hydration rate of dried pea during hydration rate at Ambient and 60°C temperature.

Time (h)	Ambient Temperature					60^0C Temperature				
	SD	SLD	TD_{50C}	TD_{60C}	TD_{70C}	SD	SLD	TD_{50C}	TD_{60C}	TD_{70C}
0	0	0	0	0	0	0	0	0	0	0
0.5	1.861	1.739	1.820	1.686	1.670	1.365	1.281	1.354	1.254	1.263
1.0	0.261	0.206	0.268	0.216	0.257	0.496	0.469	0.467	0.432	0.418
1.5	0.174	0.153	0.093	0.115	0.107	0.207	0.183	0.187	0.180	0.171
2.0	0.048	0.063	0.070	0.049	0.048	0.093	0.097	0.093	0.092	0.096
2.5	0.025	0.037	0.037	0.035	0.039	0.074	0.064	0.075	0.065	0.069
3.0	0.021	0.027	0.019	0.025	0.021	0.041	0.042	0.039	0.040	0.050
3.5	0.017	0.016	0.017	0.019	0.012	0.035	0.026	0.027	0.022	0.012

Table 3: Moisture ratio of dried pea after hydration at Ambient and 60°C temperature.

Time (h)	Ambient Temperature					60°C Temperature				
	SD	SLD	TD_{50C}	TD_{60C}	TD_{70C}	SD	SLD	TD_{50C}	TD_{60C}	TD_{70C}
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.5	4.86	7.04	6.45	11.45	12.78	3.83	5.45	5.05	8.77	9.91
1.0	5.95	8.47	8.06	14.13	16.40	5.89	8.71	7.85	14.13	15.80
1.5	7.03	9.74	8.90	16.28	18.66	7.18	10.62	9.53	17.48	19.42
2.0	7.43	10.62	9.74	17.48	20.02	7.96	11.97	10.65	19.76	22.14
2.5	7.71	11.25	10.30	18.55	21.38	8.73	13.08	11.77	21.77	24.55
3.0	7.97	11.81	10.65	19.49	22.29	9.24	13.95	12.47	23.24	26.67
3.5	8.21	12.20	11.00	20.29	22.89	9.76	14.59	13.03	24.18	27.27

The moisture ratio of the dried green peas after soaking of 3.5 h at two temperatures was ranged for SD (8.21), SLD (12.2) TD_{50C} (11.00), TD_{60C} (20.29), and TD_{70C} (22.89) at ambient temperature while at 60°C observed for SD (9.76), SLD (14.59) TD_{50C} (13.03), TD_{60C} (24.18), and TD_{70C} (27.27). Data of moisture ratio versus soaking time for dried green peas at two temperature is shown in Table 3. Initially score of moisture ration for all types of samples was calculated 1.0 while the highest value was found 27.27 for TD_{70C} sample soaked at 60°C temperature and lowest for sundried green peas at ambient temperature after 3.5 h (soaking time). The result indicates that as the water absorption by green dried peas increased along with soaking time and temperatures.

Mathematical modelling for prediction of hydration behavior of dried green peas: Regression techniques and MS Excel were used to fit the linearized forms of the Newton/Lewis model and Peleg Model/equations to experimental data in order to get the models' constants. The coefficient of determination (R2) and improved prediction were taken into consideration when choosing the model.

Table 4: Model's constant of soaked dried peas.

Soaking condition	Dried Samples	Newton & Lewis's model [MR = exp (-kt)]		Peleg's Model [(t/Mo-M) = K_1+K_2t]		
		k	R^2	k_1	k_2	R^2
Ambient Temp.	SD	-0.0285	0.7559	0.0018	0.0054	0.9807
	SLD	-0.0442	0.7829	0.0022	0.0058	0.9750
	TD_{50C}	-0.0391	0.7604	0.0019	0.0057	0.9800
	TD_{60C}	-0.0753	0.7714	0.0022	0.0061	0.9774
	TD_{70C}	-0.0862	0.7626	0.0021	0.0061	0.9800
60^0C	SD	-0.0387	0.8992	0.0032	0.0041	0.9078
	SLD	-0.0604	0.8957	0.0034	0.0044	0.9107
	TD_{50C}	-0.0532	0.8942	0.0032	0.0043	0.9157
	TD_{60C}	-0.1031	0.8947	0.0035	0.0046	0.9139
	TD_{70C}	-0.1177	0.9010	0.0035	0.0046	0.9105

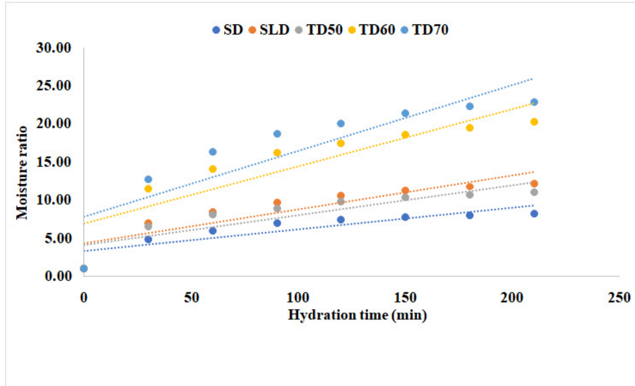

Fig. 1. Effect on moisture ratio of dried pea during soaking at normal temperature (Lewis & Newton Model).

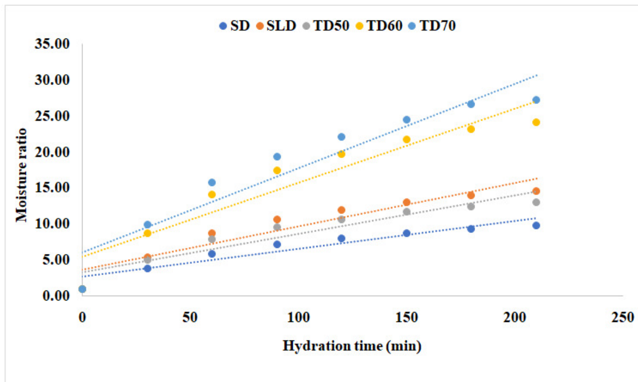

Fig. 2. Effect on moisture ratio of dried pea during soaking at 60°C temperature (Lewis & Newton Model).

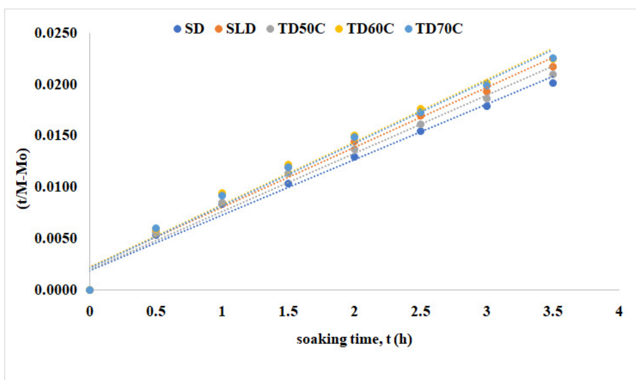

Fig. 3. Effect on moisture ratio of dried pea during soaking at normal temperature (Peleg's Model).

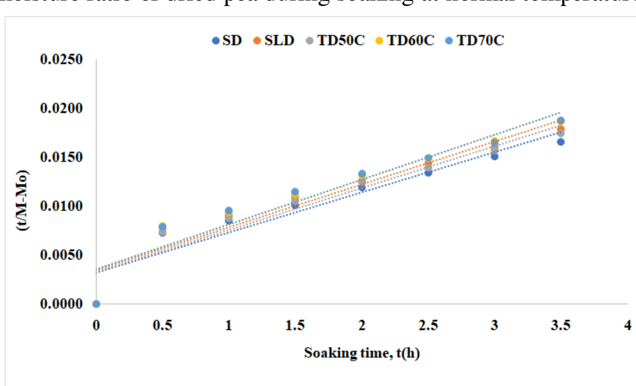

Fig. 4. Effect on moisture ratio of dried pea during soaking at 60°C temperature (Peleg's Model).

Newton / Lewis's model: The relationship between the moisture ratio and soaking time was used to determine the hydration constant (k) for this model [MR = exp (-kt)]. On semi-logarithmic paper, a graph was created that shows the relationship between soaking time and moisture ratio and is almost straight (Figs. 1 & 2). Table 4 shows the hydration constants for all drying techniques and temperatures that were used. The value of k varied from -0.0285 to -0.1177 for all the soaking experiments and with average value of -0.6464. The average value of k at ambient and 60°C temperature of soaking was estimated -0.0054 and 0.0746, respectively. The value of R^2 were varied from 0.7759 to 0.9010 with an average value of 0.8318. The average value of coefficient of determination R^2 at ambient and 60^0C temperature of soaking of dried green peas was estimated 0.7666 and 0.8969, respectively. In case of Newton & Lewis model was found fit for soaking of dried green peas soaked at 60°C temperature in water upto 3.5 h as compared to ambient temperature (Table 4).

Peleg's Model: The hydration constant *i.e.,* Peleg's rate constant (K_1) and capacity constant (K_2) of dried green peas (KPS 10) determined by the equation [(t/M-Mo) = K_1+K_2t] at different temperatures of ambient temperature (AT)and 60°C are presented in Table 4. The graph is plotted between (t/M-Mo) and soaking time (t) showed in Fig. 3 & 4. It gives a straight line where K_1 is the intercept on the ordinate and K_2 is the slope of the line. The value of Peleg's rate constant (K_1) varied from 0.0018 to 0.0035 while capacity constant (K_2) varied from 0.0041 to 0.0061. The coefficient of determination (R^2) ranged between 0.9078 to 0.9807 indicating good fit of experimental data to Peleg's model at different examined temperature. In the current study, Table 4, for the two tested soaking temperatures, the constant K_1 exhibited a tendency to grow with soaking temperature while K_2 declined with increasing soaking temperature. The results of this investigation showed that K_1 values directly correlated with temperature, indicating that the rate at which water was absorbed increased with rising temperatures. Peleg's equation could be used to estimate the moisture content at a specific soaking time and temperature within the experimental conditions taken into consideration. It correctly represented the water absorption behavior of dried green peas during the soaking process at different temperatures. For dried green peas, the Peleg's constant K_1 is a function of temperature and rises as the soaking temperature rises. The values of K_1 and K_2, derived by fitting the Peleg model at the specified temperatures, are displayed in Table 4. Higher K_1 corresponds to a higher initial rate of water absorption. K_1 is a constant that is connected to mass transfer rate.

As the soaking temperature increased (from AT to 60°C), the constant K_2 fell. The maximal water absorption capacity is correlated with the constant K_2, meaning that the higher the water absorption capacity, the lower the K_2 value. The K_2 increased linearly as the soaking temperature of dried green peas (KPS-10) increased due to their increased capacity to absorb water. The impact of temperature on food materials' water absorption capacity, specifically on K_2, varies depending on the kind of material and whether the moisture content of the samples is calculated taking into account the loss of soluble solids during soaking (Abu-Ghannan and Mckenna 1997; Sayar *et al.,* 2001). The structure of the cell wall, the makeup of the seed, and the density of the cells within the seed all affect the seed's ability to absorb water (Prasad *et al.,* 2010).

Validation of Models: Table 4 displays the constants for the models used to soak dried green peas. Based on a high coefficient of determination (R^2) value, the optimal model was identified to explain the hydration behavior of dried green peas. High R^2 value is found to be a sign of the empirical relationship's good fitness to describe the fluctuation in the moisture ratio with soaking time. The value of coefficient of determination (R^2) were estimated by Lewis's Model (0.7759 to 0.9010) with an average value of 0.8318 while Peleg's Model (0.9078 to 0.9807) with an average value 0.9451. The Peleg model was reported highest Coefficient of determination (R^2) as compared to Lewis's Model for soaking of dried green pea (KPS 10) with two soaking temperatures. The Peleg model was found fit of soaking of dried green pea (KPS 10).

CONCLUSIONS

Water at room temperature (AT) and 60°C was used to soak the dried green pea (KPS 10) for 3.5 hours (210 minutes). Every 30 minutes, the moisture content was determined. The results of the investigation showed that increasing soaking temperatures and times also enhanced the moisture content of dried green peas. Dried green peas had a higher rate of hydration during the first part of the soaking period. The hydration properties of dried green pea under experimental conditions are described by Newton/Lewis and Peleg's equation, *i.e.,* coefficient of determination (R^2) = 0.7759 to 0.9010 and 0.9078 to 0.9807, respectively. Less time was spent soaking in the water due to the greater soaking temperature. Compared to Newton/Lewis, the Peleg model can successfully elaborate the hydration behavior of dried green peas. Peleg's rate constant (K_1) and capacity constant (K_2) increased and decreased with increasing soaking time, respectively, when the temperature of the soaking medium was raised. Optimizing the hydration state is essential for process control and prediction since it determines the quality of the final product and the subsequent activities. The results must be taken into consideration while developing processing machinery and apparatus for dry green pea milling, cooking, and packaging. The study also showed that it is possible to forecast dried green pea water absorption properties, which can be useful in maximizing soaking conditions.

Acknowledgement. We empathetically extend my heartfelt gratitude, appreciation and venerable thanks to Department of Agricultural Engineering, SVPUAT Meerut (UP) India to provide the experimental facilities for the entire study is acknowledged.

Conflicts of Interest. None.

REFERENCES

Abu-Ghannam, N. and McKenna, B. (1997). The application of Peleg's equation to model water absorption during the soaking of red kidney beans (*Phaseolus vulgaris* L.). *Journal of Food Engineering, 32*(4), 391–401.

Addo, A. and Bart-Plange, A. (2009). Kinetics of water sorption by egusi melon (*Cucumeropsis edulis*) seeds. *ARPN Journal of Agricultural and Biological Science, 4*(6), 14-18.

Association of Official Analytical Chemists (1995). Official Methods of Analysis (16th ed.). Washington, DC: AOAC.

Becker, H. A. (1960). On the absorption of liquid water by the wheat kernel. *Cereal Chemistry, 37*(3), 309-323.

Bhattacharya, S. (1995). Kinetics of hydration of raw and roasted corn semolina. *Journal of Food Engineering, 25*(1), 21-30.

Chauhan, A.K.S. and Srivastava, K. (2009). Optimizing drying conditions for vacuum-assisted microwave drying of green peas (*Pisum sativum* L.). *Drying Technology, 27*, 761-769.

Foke, V. and Kulkarni, D. (2018). Application of Peleg's equation to model the water absorption behaviour of green gram during soaking. *International Journal of Agricultural Engineering, 11*(2), 369-372.

Haros, C. M., Viollaz, P. E. and Suarez, C. (1995). Effect of temperature and SO_2 on the rate of water absorption of three maize hybrids. *Journal of Food Engineering, 25*(4), 473-482.

Hsu, K.H. (1983a). A diffusion model with a concentration-dependent diffusion coefficient for describing water movement in legumes during soaking. *Journal of FoodScience, 48*(2), 618–622, 645.

Hsu, K.H. (1983b). Effect of temperature on water diffusion in soybean. *Journal of Food Science, 48*(4), 1364–1365.

Jideani, V. A. and Mpotokwana, S. M. (2009). Modeling of water absorption of Botswana bambara varieties using Peleg's equation. *Journal of Food Engineering, 92*, 182–188.

Kashaninejad, M., Maghsoudlou, Y., Rafiee, S. and Khomeiri, M. (2007). Study of hydration kinetics and density changes of rice (Tarom Mahali) during hydrothermal processing. *Journal of Food Engineering, 79*, 1383–1390.

Kashiri, M., Kashaninejad, M. and Aghajani, N. (2010). Modeling water absorption of sorghum during soaking. *Latin American Applied Research, 40*, 383-388.

Lewis, W.K. (1921). The Rate of Drying of Solid Materials. *Journal of Industrial and Engineering Chemistry, 13*, 427-432.

Maharaj, V. and Sankat, C. K. (2000). Rehydration characteristics and quality of dehydrated dasheen leaves. *Canadian Agricultural Engineering, 42*, 81–85.

Mohanty, S. N., Bal, S., Dash, K. S. and Panda, M. K. (2002). Hydration characteristics of dried green pea. *Journal of Agricultural Engineering, 39*(1), 1-8.

Muthukumarappan, K. and Gunasekaran, S. (1991). Changes in corn microstructure during pressure hydration. ASAE Paper nr 91-6543. St Joseph, Mi: ASAE.

Peleg, M. (1988). An empirical model for the description of moisture sorption curves. *Journal of Food Science, 53*(4), 1216–1217.

Prasad, K., Vairagar, P. R. and Bera, M. B. (2009). Temperature dependent hydration kinetics of Cicer arietinum splits. *Food Research International, 43*, 483–488.

Sayar, S., Turhan, M. and Gunasekaran, S. (2001). Analysis of chickpea soaking by simultaneous water transfer and water starch reaction. *Journal of Food Engineering, 50*, 91-98.

Shittu, T. A., Awonorin, S. O. and Raji, A. O. (2004). Evaluating some empirical models for predicting water absorption in African breadfruit *(Treculia Africana)* Seeds. *International Journal of Food Properties, 7*(3), 585–602.

Singh, B. P. N. and Kulshrestha, S. P. (1987). Kinetics of water sorption by soybean and pigeon pea grains. *Journal of FoodScience, 52*(6), 538–1541.

Sopade, P.A., Ajisegiri, E. S. and Badau, M. H. (1992). The use of Peleg's equation to model water absorption in some cereal grains during soaking. *Journal of Food Engineering, 15*(4), 269–283.

Sopade, P. A., Xun, P.Y., Halley, P. J. and Hardin, M. (2007). Equivalence of the Peleg, Pilosof and Singh-Kulshrestha models for water absorption in food. *Journal of Food Engineering, 78* (2), 730–734.

Taiwo, K.A., Akanbi, C. T. and Ajibola, O. O. (1998). Regression relationships for the soaking and cooking properties of two cowpea varieties. *Journal of Food Engineering, 37*(3), 331–344.

Turhan, M., Sayar, S. and Gunasekaran, S. (2002). Application of Peleg model to study water absorption in chickpea during soaking. *Journal of Food Engineering, 53,* 153–159.

Vasudeva, S., Vishwanathan, K. H., Aswathanarayana, K. N. and Indhudhara, S. Y. M. (2010). Hydration behaviour of food grains and modelling their moisture pick up as per Peleg's equation: Part I. Cereals. *Journal of Food Science and Technology, 47*(1), 34–41.

Vengaiah, P. C., Raigar, R. K., Srivastav, P. P. and Majumdar, G. C. (2012). Hydration characteristics of wheat grain. *Agricultural Engineering International: CIGR Journal, 14* (1), 116—119.

Verma, R. C. and Prasad, S. (1999). Kinetics of absorption of water by maize grains. *Journal of Food Engineering, 39*, 395-400.

YiZang, T., Bakshi, A. S., Gustafson, R. J. and Lund, D. B. (1984). Finite element analysis of nonlinear water diffusion during rice soaking. *Journal of Food Science, 49*(1), 246–250, 277.

How to cite this article: Suresh Chandra and Anuj Choudhary (2024). Hydration Behavior and Process Modeling of Dried Green Peas (KPS 10). *Biological Forum – An International Journal, 16*(9): 117-123.