Research Article

Drying of Onion Paste to Develop Powders by Foam-Mat Drying Process using Egg Albumin as Foaming Agent

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Abstract | Onion (*Allium cepa*) is a biennial, herbaceous, winter seasoned and cross-pollinated bulb crop belonging to Family *Alliaceae.* High moisture content of onion render it to be affected by microbial and enzymatic spoilage. Drying is a very effective way to preserve onion for a long time. Onion powder was prepared by foam mat drying technique in which onion paste was treated with different concentration of soy protein (0%, 4%, 8% and 12%) as foaming agent and Carboxyl methylcellulose (0.5%) as foam stabilizer and these were dried in hot air tray drier at different temperatures (55°C, 65°C and 75°C) with 3mm sheet thickness of onion foams. Effect of different concentration of foaming agent and drying temperature was studied on moisture loss drying rate of onion paste. Increase in concentration of foaming agent significantly increased the drying rate from 0.422± 0.169 (Control) to 0.744± 0.169 (soy protein). Foamed onion paste were dried faster than un-foamed which decreased the drying time of 5 hours for foamed onion paste at 65°C and 75°C. Foamed onion pastes were dried in 300, 240 and 300 min at 55°C, 65°C and 75°C temperature respectively, with 12 % concentration of soy protein as foaming agent while un-foamed pastes were dried in 600, 420 and 480 mints at 55°C, 65°C and 75°C temperature respectively. Soy protein 12% and 65°C drying temperature was found best for drying of onion paste to develop powder.

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Introduction

Preservation of food has been a keen interest of human beings to increase the shelf life and to make the availability of food material for a long time. In the season fruits and vegetables are available in surplus amount and if these food materials are not preserved by any mean then it may result into wastage off these food materials. It is reported that in developing countries almost 40% of our agricultural products are wasted due to lack of proper processing, preservation and storage facilities for these produce (Lombard *et al.*, 2008). These food spoilages may come from many sources during harvesting, handling, processing and storage of foods but most important are microbial and chemical spoilages (Gram *et al*., 2002). Vegetables are considered most susceptible to spoilage due to the microbial attack and various kind of chemical changes (Tournas, 2005). And if these spoiled foods which harbor a high load of microbes are consumed result in to several kind of human health complication because of foodborne pathogens in spoiled food materials (Abadias *et al*., 2008). Different kind of the microbes highly dependent upon the availability of water and the vegetables containing higher water activity have much more chances to be spoiled because of these microorganisms.

Dehydration or drying is the most efficient way to reduce the water activity of these kind of vegetables to prevent their spoilage (Mayor *et al*., 2004; Koc *et al*., 2008). There are number of food preservation techniques such as canning, curing, fermenting or acidifying and dehydration. Among all of these dehydration is most important and widely used because of being cost effective in term of packaging, storage and transportation of food material (Chavan and Amarowicz, 2012). Dehydration is one of the oldest method of food preservation in which water is removed or made unavailable in food materials. As water is the main component of the food which is required for microbial and enzymatic activity, more over chemical reactions also take place in availability of water. So, that is a water activity of different vegetables which define their stability (Farkas, 2007).

Market value of dehydrated vegetables is increasing in many countries due their stability and longer shelf life as compare to fresh vegetables (Zhang *et al*., 2006). Vegetables are dried by application of heat which evaporate their water contents. There are different methods for drying of vegetables like as sun drying, freeze drying, microwave drying, vacuum drying and infrared drying. Vegetables have many compounds such as phenolic and vitamins and these compounds are very sensitive to high temperature that's why selection of the drying technique depends upon final quality of end product, cost and many others factors, which should be kept in mind during selection of appropriate drying technique (Sagar and Kumar, 2010). A new technique name as foam-mat drying which is highly suitable for those foods which are sticky, very viscous and sensitive to high temperature, variety of food material can be dried by this technique with minimum quality changes (Kadam *et al*., 2010). Many researchers conducted experiments to study the foam-mat drying process for (Kadam *et al*., 2012) pineapple, (Dehghannya *et al*., 2018) lime juice, (Sankat *et al*., 2004) banana, (Zheng *et al*., 2009) black currant pulp and (Alakali *et al*., 2009) mango pulp to develop powders. All they have found that drying with foaming treatment increased the drying rate and minimized the quality changes by decreasing the water activity of powders. Our present study is also about foam-mat drying of onion paste and to investigate the effect of different concentration of soy protein as a foaming agent on moisture loss and drying rate of onion paste.

Materials and Methods

Procurement and preparation of raw material

Onions were purchased from a local vegetable market, sorted for good quality without bruises, cuts and microbial attacks. Which were peeled off, washed and grinded with grinder and converted into paste in fruits and vegetable lab at Institute of Food Science and Technology, Soy protein was purchased from a scientific store (Abdullha Traders) Faisalabad and used as a foaming agent in different concentration.

Development of onion foams by soy protein

Onion paste weighing 200g was taken for each experiment and treated with different concentration of soy protein (0%, 4%, 8% and 12%) as foaming agent. Carboxyl Methyl cellulose (0.5%) was used as a foam stabilizer. Onion paste, foaming agent and foam stabilizer in determined concentration were mixed in a 1000ml beaker and beating was done for 3 minutes to increase surface area of onion paste by developing stable foams with incorporation of maximum amount of air in onion paste by using a small scale hand beater used in kitchen for beating of eggs.

Foam spreading in trays and drying

Foams of onion paste subjected to different concentration of soy protein (0%, 4%, 8% and 12%) as foaming agent were spread to 3mm sheet thickness on aluminum foils and placed in stainless steel trays. Commercially available hot air tray dryer (Model# R-5A, Serial# 10-213, Commercial dehydrator systems, Inc.) was used for drying experiment in fruits and vegetable lab at Institute of Food Science and Technology, Drying was carried out in 3 batches, first batch was dried at 55°C comprising on four samples, one (Controlled) not treated with any foaming agent while three others which were treated with 4%, 8% and 12% concentration of soy protein, respectively. All the four samples were prepared again with same above mentioned concentrations of foaming agent and dried at 65°C and 75°C. During drying experiment after each 60 minutes' weight of all samples were recorded and when constant weight was appeared, all the samples from the dryer were removed and placed in desiccator.

Milling and storage of powder

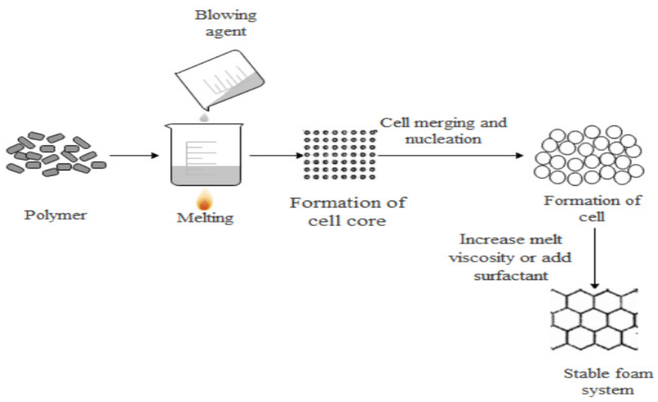
All the samples were removed from the desiccator and grounded in a grinder to develop free flowing powders. All the samples were stored at room temperature in polythene bags.

Moisture loss and drying rate

During the drying experiments of onion foams developed by different concentration of soy protein as foaming agent at different drying temperatures. Weight of each sample was recoded after an hour by a weighing balance, which was used to determine the decrease in moisture content of onion foams during drying process. Initial moisture content in onion foams were calculated by AOAC (2017) standard method of moisture calculation. Final moisture content of onion powders was also measured. By using the data of decrease in moisture of different samples drying rate was calculated by using $\Delta X/\Delta t$.

Drying curves

Drying curves for moisture loss and drying rate was plotted by using the data of moisture loss X from onion foams and drying rate $\Delta X/\Delta t$ verses time. Drying curves give information to know about exact drying time where these onion foams are dried. By these drying curves we can have idea about the best concentration of soy protein and temperature where sample dried in minimum time.



Schematic diagram of the foaming process system

Results and Discussion

Onion powder was produced by using soy protein in different concentration levels. Data for moisture loss for onion powders developed by different concentration levels of soy protein as foaming agent for which values are given in Tables 1, 2 and 3 which were used to draw drying curves for moisture loss which can be seen in Figures 1, 2 and 3 for drying at 55°C, 65°C, and 75°C. From the available data it was observed that moisture content decreased with time. Analysis of variance (ANOVA) showed highly significant effect of foaming agent and temperature ($P<0.01$). Foaming treatment resulted in faster drying as compare to non-foamed onion paste drying. Drying was fast for all above experiments in which foaming agents was used. Initially 200g onion paste sample was taken which contained 184g of moisture content and dried to achieve constant weight in try drier at 55°C, 65°C and 75°C. At 55°C onion paste without foaming agent (Control) take 10 hours to dry while onion pastes subjected to different concentration of soy protein dried faster and saved 5 hours which can be seen in Table 1. As foaming treatment increases the surface area for drying which is resulted in better and faster removal of moisture content from onion paste. While removal of moisture from un-foamed onion paste was slow because of dense structure which resulted in slow moisture reduction. Increase in concentration of foaming agent resulted in faster drying. Fastest drying of onion paste at 55°C was observed for 12% concentration of soy protein as foaming agent. As indicated in Figures 1, 2 and 3 increases in temperature resulted in significantly drop in moisture content of onion powders. Dehghannya (2019); Kadam *et al.* (2011) reported similar results. In this research descending trend in moisture content of onion powders were observed with increase in temperature for which values are given in Tables 1, 2 and 3.

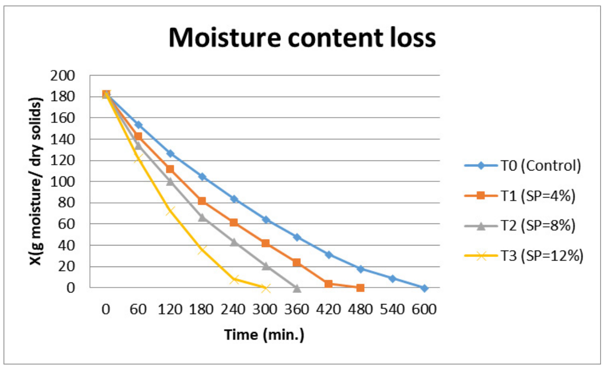


Figure 1: *Effect of soy protein concentration level on moisture during foam mat drying of onion paste at 55°C.*

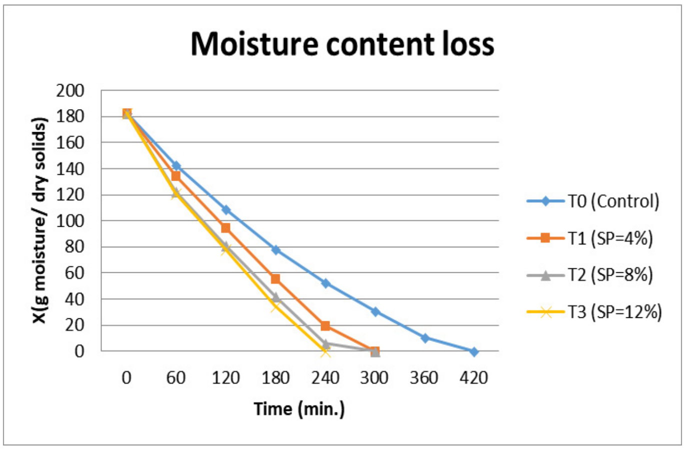


Figure 2: *Effect of soy protein concentration level on moisture during foam mat drying of onion paste at 65°C.*

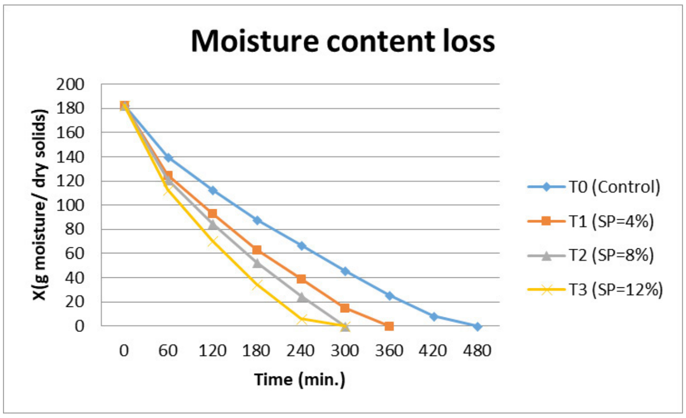


Figure 3: *Effect of soy protein concentration level on moisture during foam mat drying of onion paste at 75°C.*

Table 1: *Moisture loss from onion paste drying at 55°C temperature using different concentration of soy protein as foaming agent.*

Drying of onion paste at 55°C temperature					
S. No.	Time, t (min)	Moisture content, X (g moisture/g dry solid)			
Treatments		T_0 (Control)	T_1 (SP=4%)	T_2 (SP=8%)	T_3 (SP=12%)
1	0	183	183	183	183
2	60	154	143	135	123
3	120	127	112	101	73
4	180	105.3	82	67	36
5	240	84	62	44	8
6	300	64.7	42	21	0
7	360	48.4	24	0	
8	420	32	4		
9	480	18.5	0		
10	540	9			
11	600	0			

Table 2: *Moisture loss from onion paste drying at 65°C temperature using different concentration of soy protein as foaming agent.*

Drying of onion paste at 65°C temperature					
S. No.	Time, t (min)	Moisture content, X (g moisture/g dry solid)			
Treatments		T_0 (Control)	T_1 (SP=4%)	T_2 (SP=8%)	T_3 (SP=12%)
1	0	183	183	183	183
2	60	143.2	135	123	121
3	120	109	95.12	81	78
4	180	78	55.7	42	35
5	240	53	19.7	6	0
6	300	31	0	0	
7	360	11			
8	420	0			

Table 3: *Moisture loss from onion paste drying at 75°C temperature using different concentration of soy protein as foaming agent.*

Drying of onion paste at 75°C temperature					
S. No.	Time, t (min)	Moisture loss, X (g moisture/g dry solid)			
Treatments		T_0 (Control)	T_1 (SP=4%)	T_2 (SP=8%)	T_3 (SP=12%)
1	0	183	183	183	183
2	60	140.3	125	121	113
3	120	113	93	85	71
4	180	88	63	53	35
5	240	67	39	25	6
6	300	46	15	0	0
7	360	26	0		
8	420	8			
9	480	0			

Drying rate was calculated and used to draw drying rate curves for which data is given in Tables 4, 5 and 6. Drying rate for the onion powder at 55°C, 65°C and 75°C were evaluated by drying curves shown in Figures 4, 5 and 6 for drying at 55°C, 65°C and 75°C. Drying curves were drawing with the data on the rate of drying versus time. Falling rate period was observed with passage of time because in start of the drying onion paste contains very high water content while with the passage of time during drying water content decrease and it became hard to remove moisture from inside of the sample. Hence, drying rate decreases with time. Mean values for drying rate of onion paste

Table 4: *Drying rate of onion paste at 55°C using different concentration of soy protein as foaming agent.*

S. No.	Time	Drying rate at 55°C, N (g/cm²min)			
Treatments		T_0 (Control)	T_1 (SP=4%)	T_2 (SP=8%)	T_3 (SP=12%)
1	0	0	0	0	0
2	60	0.453± 0.025	0.656± 0.012	0.790± 0.010	0.986± 0.015
3	120	0.423± 0.025	0.520± 0.020	0.560± 0.010	0.783± 0.042
4	180	0.350± 0.017	0.503± 0.015	0.563± 0.012	0.660± 0.035
5	240	0.346± 0.025	0.306± 0.021	0.380± 0.020	0.440± 0.017
6	300	0.330± 0.017	0.303± 0.023	0.393± 0.015	0.120± 0.017
7	360	0.286± 0.016	0.283± 0.015	0.350± 0.020	0
8	420	0.243± 0.025	0.330± 0.010	0	
9	480	0.193± 0.023	0.070± 0.010		
10	540	0.130± 0.026	0		
11	600	0.156± 0.011			
12	660	0			

Table 5: *Drying rate of onion paste at 65°C using different concentration of soy protein as foaming agent.*

S. No.	Time	Drying rate at 65°C, N (g/cm²min)			
Treatments		T_0 (Control)	T_1 (SP=4%)	T_2 (SP=8%)	T_3 (SP=12%)
1	0	0	0	0	0
2	60	0.650± 0.010	0.806± 0.020	1.013± 0.015	1.006± 0.020
3	120	0.570± 0.010	0.630±0.026	0.650± 0.026	0.710± 0.017
4	180	0.503± 0.015	0.663± 0.005	0.626± 0.025	0.693± 0.023
5	240	0.423± 0.050	0.593± 0.005	0.610± 0.034	0.566± 0.011
6	300	0.346± 0.025	0.323± 0.030	0.596± 0.015	0
7	360	0.306± 0.020	0	0	
8	420	0.153± 0.025			
9	480	0			

Table 6: *Drying rate of onion paste at 75°C using different concentration of soy protein as foaming agent.*

S. No.	Time	Drying rate at 75°C, N (g/cm²min)			
Treatments		T_0 (Control)	T_1 (SP=4%)	T_2 (SP=8%)	T_3 (SP=12%)
1	0	0	0	0	0
2	60	0.700± 0.010	0.970± 0.020	1.016± 0.011	1.143± 0.030
3	120	0.453± 0.011	0.516±0.023	0.600± 0.020	0.703± 0.015
4	180	0.436± 0.015	0.493± 0.011	0.523± 0.011	0.586± 0.011
5	240	0.340± 0.017	0.416± 0.015	0.473± 0.015	0.486± 0.005
6	300	0.333± 0.015	0.413± 0.032	0.416± 0.005	0.103± 0.015
7	360	0.296± 0.012	0.220± 0.030	0	0
8	420	0.136± 0.011	0		
9	480	0			

Table 7: *Mean drying rate of onion powder dried at different temperatures (55°C, 65°C and 75°C) using different concentration of soy protein as foaming agent.*

		Mean drying rate			
S. No	Temperature	T_0 (Control)	T_1 (SP=4%)	T_2 (SP=8%)	T_3 (SP=12%)
1	55°C	0.291± 0.109	0.371± 0.273	0.506± 0.273	0.598± 0.273
2	65°C	0.422± 0.169	0.603± 0.169	0.699± 0.169	0.744± 0.169
3	75°C	0.385±0.174	0.512± 0.174	0.606± 0.174	0.604± 0.174

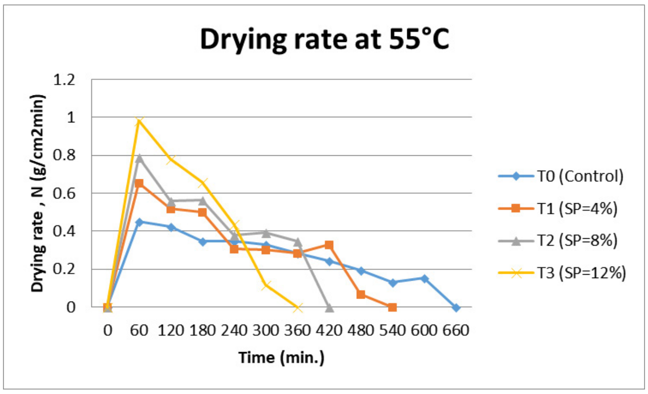


Figure 4: *Effect of soy protein concentration level on drying rate of foam mat dried onion paste at 55°C.*

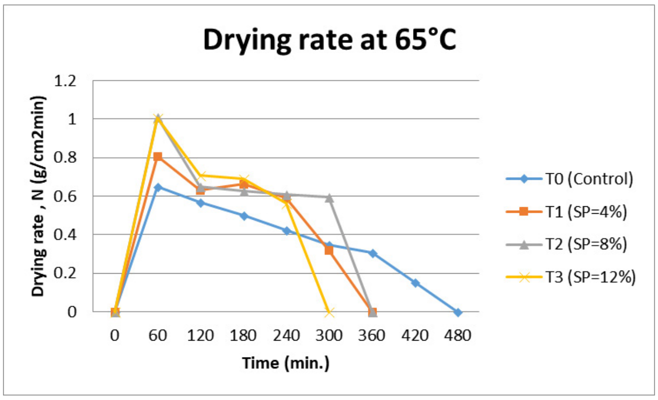


Figure 5: *Effect of soy protein concentration level on drying rate of foam mat dried onion paste at 65°C.*

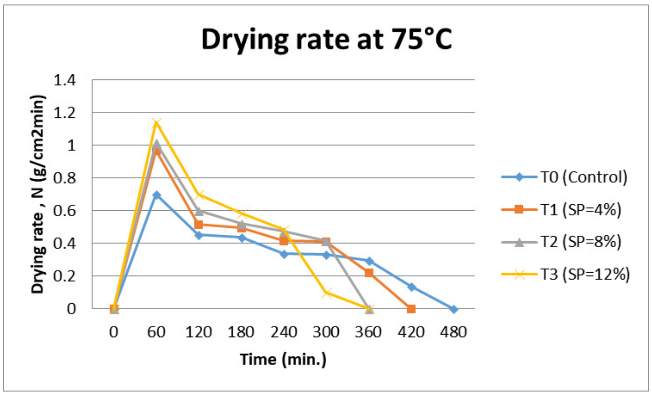


Figure 6: *Effect of soy protein concentration level on drying rate of foam mat dried onion paste at 75°C.*

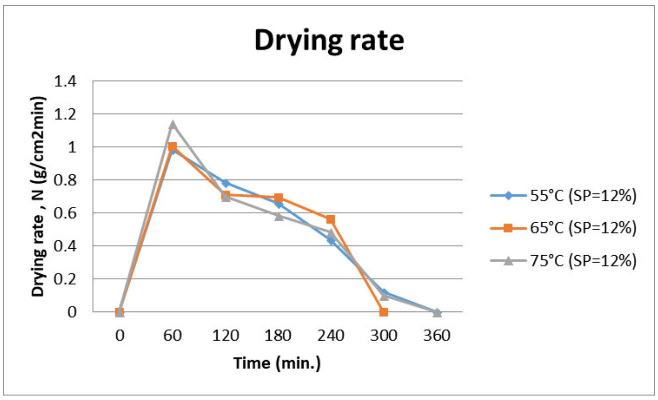


Figure 7: *Effect of different temperatures (55°C, 65°C and 75°C) on drying rate of onion powders developed by 12% soy protein as foaming agent.*

dried at 55°C, 65°C and 75°C by using different concentration of soy protein (4%,8% and 12%) as foaming agents are given in Table 7. From the data it is shown that highest drying rate for soy protein 0.744± 0.169 at 65°C with 12% concentration.

Conclusions and Recommendations

Onion powder was prepared by foam-mat drying technique using soy protein in different concentration as foaming agent. Effect of foaming agent and different drying temperature was studied on moisture loss and drying rate of onion paste. From the results it was found that onion paste which was treated with different concentration of soy protein as foaming agent was dried in short time as compare to un-foamed onion paste. Moisture loss from foamed onion paste was higher because with foaming treatment surface area for drying was increased which resulted into faster and easy removal of moisture of foamed onion pastes. Moreover, drying rate of onion pastes which were treated with different concentration of soy protein was higher as compare to un-foamed onion pastes.

Novelty Statement

The present study will very helpful to understand Drying of Onion Paste With Using Egg Albumin

Author's Contribution

M. Javed Iqbal and Rizwan Shukat: Wrote the Original draft.
Muhammad Farooq: Reviewed and edited the whole article.
Iftikhar Ahmed Solangi: Wrote material and Methods.
Rahman Ullah and A. Shakoor: Reviewed the article.
Naila Ilyas: Helped in introduction.
Faraz Ahmed: Wrote the discussion.
Muhammad Bakhtiar: Wrote Material and Methods.

Conflict of interest

The authors have declared no conflict of interest.

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