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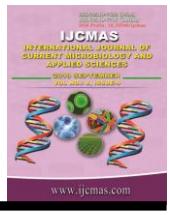

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Study of Drying Kinetics of Cauliflower (*Brassica oleracea*) using Tray Dryer

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A B S T R A C T

Cauliflower is one of several vegetables in the species *Brassica oleracea* in the genus Brassica, which is in the family Brassicaceae. The present investigation were carried out to determine the drying kinetics (Moisture content wb% & db%, dehydration ratio, average drying rate, etc.) of cauliflower under cabinet tray drying (60 ^{0}C). Moisture content (wb %) of samples ranges from 94.53 to 09.90 and moisture content (db %) ranges from 1729.49 to 10.99 at 60 ºC of tray drying temperature. Drying rate and dehydration ratio were ranged from 3.38 to 0.07 and 1.38 to 1.07 respectively.

Introduction

Cauliflower is relatively difficult to grow compared to cabbage. Failure to head properly and poor curd quality are common problems. For successful production of cauliflower, a fertile, moist soil relatively high in organic matter and nitrogen is needed. Cauliflower buttoning is the premature formation of curd, and since the curd forms very early in the plant's life, the leaves are not large enough to nourish the curd to a marketable size. Conditions that reduce the vigor of the plant and retard vegetative growth, such as cold temperatures at transplanting, appear to encourage buttoning.

Cauliflower is one of several vegetables in the species *Brassica oleracea* in the genus *Brassica*, which is in the family Brassicaceae. It is an annual plant that reproduces by seed. Typically, only the head is eaten – the edible white flesh sometimes called "curd" (Fritz *et al.,* 2017). Fruits and vegetables are important source of vitamins and their drying demands special attention for their nutritional aspects of the end product (Mudgal and Pandey 2009; Shalini *et al.,* 2009). The drying operation in

convective heating involves moisture transfer from the wet material to heated air, which may be illustrated as a transport of moisture from the material core to its surface, followed by evaporation from the surface of the material, and dissipation of water vapour into the bulk of the drying air. (Maskan *et al.*, 2002; Togrul and Pehlivan, 2002) Drying causes irreversible structural damage to the cellular structure of foods, whereby rehydration of the dehydrated product affected.

Pretreatment, subsequent drying and rehydration may induce changes in the structure and composition of plant tissues (Lewicki, 1998) which affect the organoleptic properties upon rehydration.

A number of studies for drying of fruits and vegetables have been reported by various authors (Doymaz 2006; Akpinar, 2006; Eren and Kaymak-Ertekin, 2007).

Drying is a common technique for preservation of food and other products; including fruits and vegetables. The major advantage of drying food products is the reduction of moisture content to a safe level that allows extending the shelf life of dried products.

The removal of water from foods provides microbiological stability and reduces deteriorative chemical reactions. Also, the process allows a substantial reduction in terms of mass, volume, packaging requirement, storage and transportation costs with more convenience (Okos *et al.*, 1992).

Materials and Methods

Fresh fully matured white and compact cauliflower heads were selected for the experiment. The leaves were removed and heads were thoroughly washed, trimmed to remove hard main stem and cut into pieces of 3-4 cm length and 2-3cm width.

Drying Methods

(AOAC, 2000)
Cabinet tray drying (60 ^{0}C)

Pretreatments

The cauliflowers were cut (pieces and quarter) then blanching and steeping pretreatments were given.

Blanching

Hot water blanching method was used. The samples were blanched in boiling water at 100 ºC for 3 min. The gas stove was used to boil the water and the temperature was maintained. Each time 500 gm of sample was taken and dipped into boiling water for 3 min.

Treatment with 0.25% KMS + citric acid solution (blanched+ steeped)

The samples were blanched and then drained for 30 min, cooled and then soaked in 0.25% citric acid solution along with 0.25% KMS for 30 min at room temperature. After 30 min the samples were taken out of solution and drained again before drying.

Statistical Analysis

The entire experiment was replicated three times. All the data were analyzed by MS excel and results were expressed as mean ± standard deviation (SD).

Results and Discussion

The experimental data of drying kinetics of control (T_1) cauliflower samples in tray dryer at 60 ºC is presented in Table 1. According to data, moisture content (wb %) of samples ranges from 94.53 to 09.90 and moisture

content (db %) ranges from 1729.49 to 10.99 at 60 ºC of tray drying temperature. Drying rate and dehydration ratio were ranged from 3.38 to 0.07 and 1.38 to 1.07 respectively. It took about 720 minutes to dry samples completely at 60 ºC. The experimental data of drying kinetics of blanched cauliflower samples (T_2) in tray dryer at 60 ºC is presented in Table 2.

According to data, moisture content (wb %) of samples ranges from 94.53 to 15.47 and moisture content (db %) ranges from 1729.49 to 18.31 at 60 ºC of tray drying temperature. Drying rate and dehydration ratio were ranged from 3.15 to 0.23 and 1.37 to 1.20 respectively. It took about 720 minutes to dry the samples completely at 60 ºC. The experimental data of drying kinetics of blanched + steeped cauliflower samples (T_3) in tray dryer at 60 ºC is presented in Table 3.

According to data, moisture content (wb %) of samples ranges from 94.53 to 1.38 and moisture content (db %) ranges from 1729.49 to 1.40 at 60 ºC of tray drying temperature. Drying rate and dehydration ratio were ranged from 2.96 to 0.02 and 1.59 to 1.02 respectively. It took about 720 minutes to dry the samples completely.

There is a decrease in drying rate and dehydration ratio. The moisture content decreased with increase in time but the curves of drying rate were found to be non linear during drying operation.

Table.1 Drying kinetics of control cauliflower samples in tray dryer at 60 ºC

Time (Min.)	Sample weight (g)	M.C. (%, wb)	M.C. (%, db)	Water removed (g)	Drying rate	Dehydration ratio
0	500.000	94.53	1729.49	0.00	0.00	0.00
60	407.667	93.30	1391.65	92.33	3.38	1.23
120	321.000	91.49	1074.53	86.67	3.17	1.27
180	246.667	88.92	802.55	74.33	2.72	1.30
240	186.667	85.36	583.01	60.00	2.20	1.32
300	135.333	79.81	395.18	51.33	1.88	1.38
360	98.500	72.25	260.41	36.83	1.35	1.37
420	71.333	61.69	161.01	27.17	0.99	1.38
480	51.667	47.10	89.05	19.67	0.72	1.38
540	41.000	33.34	50.02	10.67	0.39	1.26
600	35.667	23.37	30.50	5.33	0.20	1.15
660	32.333	15.47	18.31	3.33	0.12	1.10
720	30.333	9.90	10.99	2.00	0.07	1.07

Table.2 Drying kinetics of blanched cauliflower samples in tray dryer at 60 ºC

Time (Min.)	Sample weight (g)	M.C. (%, wb)	M.C. (%, db)	Water removed (g)	Drying rate	Dehydration ratio
0	500.000	94.53	1729.49	0.00	0.00	0.00
60	414.013	93.40	1414.87	85.99	3.15	1.21
120	334.140	91.82	1122.61	79.87	2.92	1.24
180	259.670	89.48	850.13	74.47	2.72	1.29
240	196.380	86.08	618.55	63.29	2.32	1.32
300	146.980	81.41	437.80	49.40	1.81	1.34
360	107.540	74.59	293.49	39.44	1.44	1.37
420	85.260	67.95	211.96	22.28	0.82	1.26
480	70.390	61.17	157.56	14.87	0.54	1.21
540	58.360	53.17	113.54	12.03	0.44	1.21
600	47.250	42.16	72.89	11.11	0.41	1.24
660	38.667	29.32	41.48	8.58	0.31	1.22
720	32.333	15.47	18.31	6.33	0.23	1.20

Table.3 Drying kinetics of blanched + steeped samples in tray dryer at 60 ºC

Time (Min.)	Sample weight (g)	M.C. (%, wb)	M.C. (%, db)	Water removed (g)	Drying rate	Dehydration ratio
0	500.000	94.53	1729.49	0.00	0.00	0.00
60	419.000	93.48	1433.11	81.00	2.96	1.19
120	341.670	92.00	1150.16	77.33	2.83	1.23
180	269.330	89.85	885.47	72.34	2.65	1.27
240	202.330	86.49	640.32	67.00	2.45	1.33
300	148.330	81.57	442.74	54.00	1.98	1.36
360	103.000	73.47	276.88	45.33	1.66	1.44
420	67.670	59.61	147.60	35.33	1.29	1.52
480	42.670	35.95	56.13	25.00	0.91	1.59
540	32.333	15.47	18.31	10.34	0.38	1.32
600	29.201	6.41	6.85	3.13	0.11	1.11
660	28.308	3.45	3.58	0.89	0.03	1.03
720	27.712	1.38	1.40	0.60	0.02	1.02

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