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ORIGINAL ARTICLE

Development of Tomato Powder by Using Microwave Drying Technique

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Abstract

The higher water content of tomato makes them highly perishable. Tomato was dried to enhance storage stability, minimize packaging requirement and reduce transport weight. The microwave drying behavior of tomato wedges was investigated experimentally to determine the effects of microwave power on the drying rate and dried product quality in terms of color and drying behavior of tomato wedges. The experiments were performed with the microwave power of 900 W to 90 W at 10 different levels of power and also using step by step decreasing microwave power drying technique. The result indicates that the drying time decreased considerably with increased microwave power. The experiments also revealed that the drying rate initially increases, followed by constant drying rate for some period and then undergo the falling rate drying period during rest of entire drying period. The color quality of the product deteriorates significantly with the increase in the microwave power used for drying purpose. It is observed that color (red) of the tomato powder on drying from 900 W to at 90 W microwave power, was turning from darker (burning effect) to lighter (no burning) one. In step by step decreasing microwave power drying technique, the sample obtained was found to have color closer to that of fresh tomato and also at par with sample dried at 90 W of microwave power. However, the drying time required for sample dried by step by step decreasing microwave power drying technique was 1.33 h as compared to 7 h required for drying at 90 W, thus saving 80 % of total drying time to achieve similar effect. It is suggested that microwave drying should be done in between 360 W to 90 W to avoid burning of tomato sample. The sensory quality of product obtained by drying at 90 W is at par of that dried in step by step decreasing microwave power drying technique and both comparable with commercial one.

Keywords: Tomato, Wedges, Microwave drying, Burning effect.

1. Introduction

Fruits and vegetables are important ingredients of the human food as they provide the much-needed vitamins and micronutrients in the diet apart from calories (Sedani *et al.*, 2018). India's varied agro-climatic conditions provide an enormous scope for cultivation of almost all varieties of tropical, sub-tropical and temperate fruits and vegetables. India is the world's fruit and vegetable basket. India is the second largest producer of fruits (81.285 million tonnes) and vegetables (162.19 million tonnes) in the world, contributing 12.6% and 14.0% of the total world production of fruits and vegetables, respectively (Anonymous, 2016). During 2016-17, the production of horticulture crops was about 295.2 million tonnes from an area of 24.9 million hectares (Anonymous, 2017). A huge quantity of these produce goes waste due to lack of handling, storage, transportation and processing facilities. The total losses of fruits and vegetables are estimated to be 30-40% amounting nearly Rs. 92000 crore per annum (MOFPI, 2016) which calls for proper preservation and processing facilities in areas where surplus quantities are grown. Many methods of food preservation rely on removal of water in order to decrease water activity below a level that causes growth retardation of spoiling microorganisms. Decreased water content also influences unwanted chemical reactions affecting not only the nutrients value of food but also its sensory properties. Further domestic and defense demands for economical and convenient food preparations in the past few years have started an ever-increasing trend towards preparations of concentrated foods produced by either partial or complete dehydrations such preparations offer reductions in cost of packaging, shipping and storing and frequently offer greater convenience in addition to longer shelf-life and higher degree of inhibition to bacterial attack. Dehydrated food saves 86% of costs incurred in shipping, 77% in storage space and 82% in handling cost (Cruess, 1958). Tomato (*Lycopersicon esculentum Mill*) is the second largest vegetable crop of India. The world production of tomato is placed at 130 million tons annually of which India's share can be estimated at about 19.697 million tones representing 11% of the world production (Anonymous, 2017). Fresh tomatoes are highly refreshing, appearing and a good source of minerals and vitamins, particularly ascorbic acid. Being perishable in nature, whole tomato, however, has shelf-life of 5-10 days at 21-34°C temperature and 45-85 percent relative humidity (Arah, 2015). Although tomato products rank first among the processed vegetables, the fact is that this industry has not progressed well in India, with only about 1-2 percent of its total produce being processed and marketed in the form of puree, paste, ketch-up, sauce, chutney, pickles etc. These products are popular and have good market in India and abroad (CFTRI, 1993). However, they continue to be produced by traditional methods involving energy intensive thermal processes which generally downgrade their quality. Short shelf-life coupled with inadequate processing facilities results in heavy annual loss (54%) of tomatoes. A need therefore exists to develop suitable technology for processing this valuable produce in a way that will not only check losses but also generate additional revenue for the country. Therefore, drying is the most suitable method to fulfill the above requirement. Tomato has the potential for meeting the increasing demand for quality fruit and vegetables juices in India and abroad. Among the various methods of preservation, dehydration is the most economical one. This is not only because dehydrated products require inexpensive packaging and almost no energy during storage, but they are also highly stable against deteriorate microbial, chemical and enzymatic reactions. The applications of various vegetables juice powders, is growing and the main field of use are in instant juices, drinks, baby foods, soups, food premixes gravies, spice mixtures, snacks bakery products, pharmaceuticals preparations, etc. For conversion into powders, majority of the fruit and vegetable juices are generally subject to two-stage moisture removal processes keeping in view energy conservation and product quality. They are first concentrated and they dried to 2-3 percent residual moisture content. Concentration is the major unit operation of critical importance as it determines the quantity of the final product. A few commercially feasible methods for concentrating aqueous foods include evaporation, freeze concentration and membrane processes, such as reverse osmosis and ultrafiltration. Though considerable progress has taken place in all these methods, evaporation is still the most developed and widely used by the industry (Ramteke *et al.,* 1993). The main limitations of freeze and membrane concentrations are the loss of soluble solids and higher capital costs. In membrane process, viscosity of the concentrate and fouling are the other serious drawbacks. Until recently, one of the most commonly used drying techniques was the convective hot air drying. However, in this drying technique, food materials are exposed to elevated temperatures, which leads to an increase in shrinkage and toughness, reduction of both the bulk density and rehydration capacity of the dried product and it also causes serious damage to flavor, color, and nutrients content (Maskan, 2000). The other major disadvantages of convective hot air drying method are the increased drying time and higher energy consumption due to the higher drying temperature. The desire to reduce the above problems led to the use of microwave and dielectric heating methods for food drying (Bondruk *et al.,* 2007). Microwave energy is rapidly absorbed by water molecules which, consequently, results in rapid evaporations of water and thus higher drying rates, therefore microwave drying offers significant energy savings, with a potential reduction in drying times in addition to the inhibition of the surface temperatures of the treated material (McLoughlin *et al*., 2003; Patil *et al.,* 2015). Keeping in view the physical, chemical and microbiological spoilage of the tomatoes by traditional sun drying process, the present study was undertaken to study drying behavior of tomatoes with objectives to study the effect of drying at different microwave power level of tomato slices.

2. Materials and Methods

2.1 Sample Preparation

Fully ripened tomatoes were purchased from local market of Akola in state of Maharashtra of India, and wedges, thereof, were prepared before drying.

2.2 Preparation of Raw Material

Tomato is cut into four equal parts, i.e., wedges. The required wedges of tomatoes were prepared using lemon cutter developed by Wagh (2017) and by Wagh *et al.,* (2019). The mean diameter (using Vernier Caliper with least count of 0.01 mm) and average weight (using weighing balance, with accuracy of 0.01 g) of the tomatoes used in the experiments were 6±0.3 cm and 50±1 g, respectively.

2.3 Experimental Set Up and Plan of Experiment

The requisite experimental set up consisted of Microwave oven having 900 W maximum power and provision of 10 levels of power and varied time setting in microwave power mode. The drying of tomato wedges was carried out at different levels of microwave power, i.e., 900 W, 810 W, 720 W, 630 W, 540 W, 450 W, 360 W, 270 W, 180 W and 90 W. The prepared samples (sample size around 50 g) were weighed using weighing balance at equal interval of 1 min for experiments conducted at microwave powers of 900 W to 450 W and at equal interval of 5 min for experiments conducted at microwave powers of 360 W to 90 W, respectively, on basis of preliminary trails, till the target moisture content was obtained.

2.4 Determination of Moisture Content

The moisture content of tomato sample was determined using vacuum oven at 70 °C for 24 h (AOAC, 1980). The moisture content of the tomato sample was computed using the following equations,

$$Moisture\ content\ (\%w.b) = \frac{M_1 - M_2}{M_1} \times 100$$

$$Rate\ of\ drying = \frac{Moisture\ content\ lost}{Time\ difference}$$

Where,

M_1 is the weight of sample before oven drying (g), M_2 is the weight of sample after oven drying (g). The weight M_2 was taken after allowing the samples to cool down up to atmospheric temperature, by keeping the samples in desiccators having filled silica gel in its bottom portion. The loss in weight of peas during drying run at level of microwave power (as in case at different drying temperatures as reported by Pradeshi *et al*., 2001) with time was transformed into moisture contents (d.b). The moisture content of the tomato with respect to the wet basis was 95.24 % wb. The equilibrium moisture content was assumed zero for microwave oven drying (Maskan, 2000).

2.5 Microwave Drying of Tomato

a) Prior to the drying experiment, the tomatoes were cut in to the wedges with the help of lemon cutter (Wagh *et al*., 2019).
b) The tomato wedges were placed on a fiber plate and loaded into microwave oven.
c) This plate placed at the centre of a turntable fitted inside the microwave cavity and processed until the wedges were completely dried.
d) The weights of drying wedges were recorded with 1minute interval for microwave power of 900 W to 450 W, using a digital balance measuring to an accuracy of (0.001 g).
e) During the drying of tomato at the power level from 360 W to 90 W, the weights of drying wedges were recorded with 5 min interval, using said weighing balance.
f) The weight measurement process took about 20 s.
g) After each experiment, the color parameters of the dried product were measured and recorded.

2.6 Colour Analysis

Colour of tomato and tomato powder was measured by a chromameter before and after drying, respectively. The colour analysis was conducted to obtain some knowledge about the quality of dried product. Three parameters, L* (lightness). a*(redness), and b*(yellowness), were used to study the colour changes. The L* refers to the lightness of the samples and ranges from black=0 to white=100. The negative value of a* indicates green, while the positive a* indicates red colours. The positive b* indicates yellow and the negative b* indicates blue colours (Babalik, 1996; Alibas, 2007). Total colour difference (Δe^*) is calculated. The following equations were used in the specification of the change in the colour parameters with respect to the fresh product:

$$\Delta a^* = \Delta a^*_{fresh} - a^* \quad \ldots (1)$$

$$\Delta b^* = \Delta b^*_{fresh} - b^* \quad \ldots (2)$$

$$\Delta L^* = \Delta L^*_{fresh} - L^* \quad \ldots (3)$$

$$\Delta e^* = \sqrt{(\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2})} \quad \ldots (4)$$

2.7 Preparation of Tomato Powder

The dried tomato wedges were ground usin mechanical grinder.

2.8 Sensory Evaluation

The soup prepared using dried tomato powder, was subjected for sensory evaluation in order to assess consumers' reaction with regard to colour, flavour, texture and overall acceptability of the dried tomato samples. Twelve members of untrained panelists were selected from students, laboratory technicians and academic staff member of Department of Agriculture Process Engineering, College of Agricultural Engineering and Technology, Dr. PDKV, Akola. All samples were coded and randomly served to panelists, and were asked to evaluate the colour, flavour, texture and overall acceptability of the dried tomato powder soup, using 9 point hedonic scale (BIS, 1971), where 1 = disliked extremely and 9 = liked extremely.

3. Results and Discussion

Tomatoes are rich sources of micronutrients, vitamins, having higher amount of moisture and have short durability, seasonability and perishability and thus explain the necessity of applying preservation techniques for it. Among various preservation methods, dehydration is most popular and traditional method. It increases the storage life and supplying important nutrients in a concentrated form. A study was undertaken on dehydration of tomatoes and its effect on quality of the same. The results are presented in this topic.

3.1 Drying Characteristics of Tomato Slices

The drying behavior was investigated for tomato sample, in form of tomato wedges, dried using microwave oven drying methods (Power of 90 W to 900 W). The variation in moisture content of dried tomato with drying time and drying rate as well as effect of microwave power nature of drying were calculated and presented in following section.

3.2 Variation in Moisture Content with Drying Time

The drying curves for the tomato wedges are shown along with the experimental data in Fig 1. It can be concluded from Fig 1, that the drying time decreases from 420 min to 26 min with the increase of microwave power from 90 W to 900 W (Table 1). The final and targeted moisture content of the entire samples, were ranging from 5 to 10 % (db) for all the samples investigated. The moisture content of drying tomato sample decreased exponentially with drying time under all drying conditions. It was seen that initially the moisture content decreased rapidly and then it slowed down considerably as seen on Fig 1. It is clear that the rate of moisture removal increased with the drying microwave power. The rate of moisture removal is higher at higher microwave power as well as higher in initial stages and reduces gradually with increases in drying time. This is due to the very high initial free surface moisture concentration in wet sample. The rate of moisture removal is higher in microwave oven with minimum time as compared to other dryings like sun drying, solar drying and hot air drying (Patil, 2015). Equilibrium moisture content was treated to be zero percent (db), as removal of moisture continues with time and subsequently product may get burnt (Soysal, 2004).

3.3 Variation in Moisture Ratio with Drying Time

Fig 2 shows the variation of moisture ratio vs. drying time for tomato samples dried at different microwave power. The curve shows the moisture ratio to be reducing during drying at all microwave power considered for drying. The curve reveals that moisture ratio was decreased faster with time in higher power of drying as compared to lower power of drying.

3.4 Variation in Drying Rate with Average Moisture Content

Drying rate of tomato slices during drying is shown in Fig 3 for drying at different microwave power levels. The drying rate increases in the early stage of drying, then remain constant for some period followed by falling drying rate periods. These drying rates were calculated from the change in moisture content which occurred in each time interval as detailed in section 2.4. The extensive dehydration studies reported that the moisture transfer during drying took place by means of capillary movement towards the surface even though the drying rate was not constant (Shinde *et al.*, 2016). Drying of tomato wedges took place under constant drying rates for considerably long period in case of samples dried at microwave power below 360 W. The similar observations are reported in case of hot air drying of green peas at lower temperature (Pardeshi *et al.*, 2009). The migration of moisture occurred through the mechanism of diffusion. Moisture diffusion from inner core to the outer core took place through the crust and moisture loss took place from inner core of tomato slices. Highest drying rates were observed during drying at 900 W power level and lowest drying rate were observed during at 90 W microwave power level.

3.5 Comparison of Different Microwave Power Level for Drying of Tomato

Tomato was dried at different microwave power level from 900 W to 90 W, separately. It was observed that the product quality improves as microwave power decreases as it is clearly indicative from colour and appearance. The colour of samples dried at high level of microwave power (900 W to 450 W) is very dark. At higher microwave power level, the higher burning effect is observed before the drying proceeds upto desired final moisture. At lower microwave power level i.e, from 360 W to 90 W, the colour found to be improving. The phenomenon and effect of burning could be described by observing the incidence of burning of tomato samples dried at different microwave power levels. The time of first incidence of burning during drying of tomato samples increased with decrease in microwave power from 900 W to 90 W. At higher level of microwave power, the burning occurred even at very high moisture level, however, the first incidence of burning occurred at prolonged time and at comparatively lower level of moisture contents,

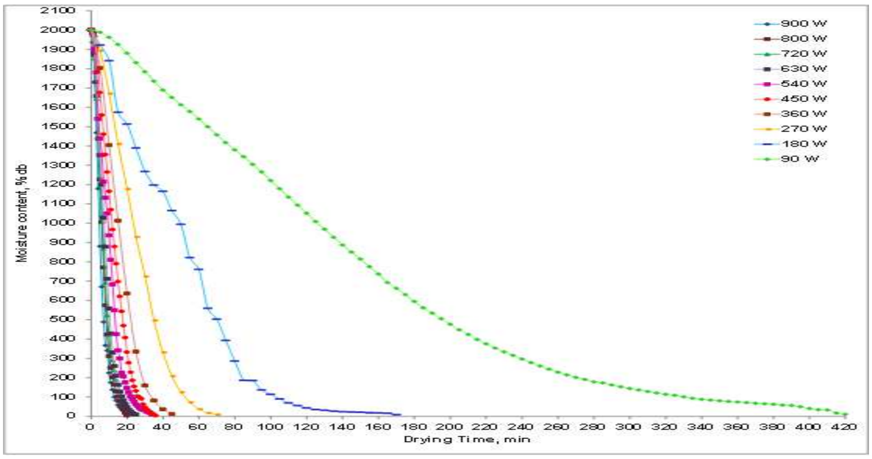

Fig 1: Variation of moisture content Vs drying time at different microwave power (W) level

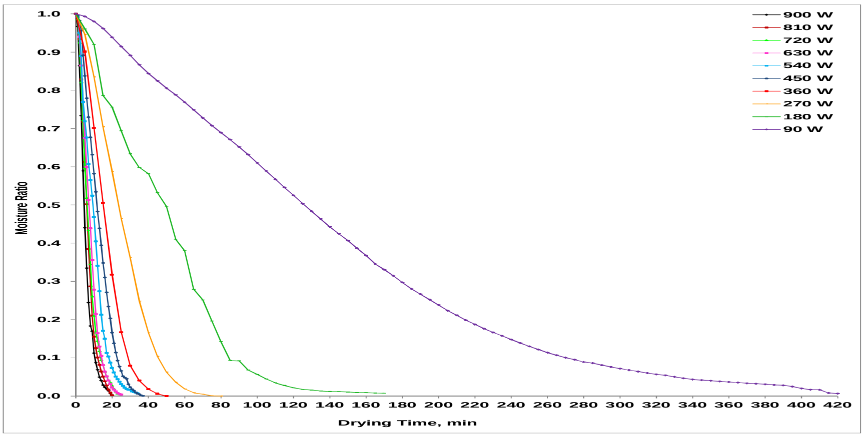

Fig 2: Variation of moisture ratio Vs drying time at different microwave power level

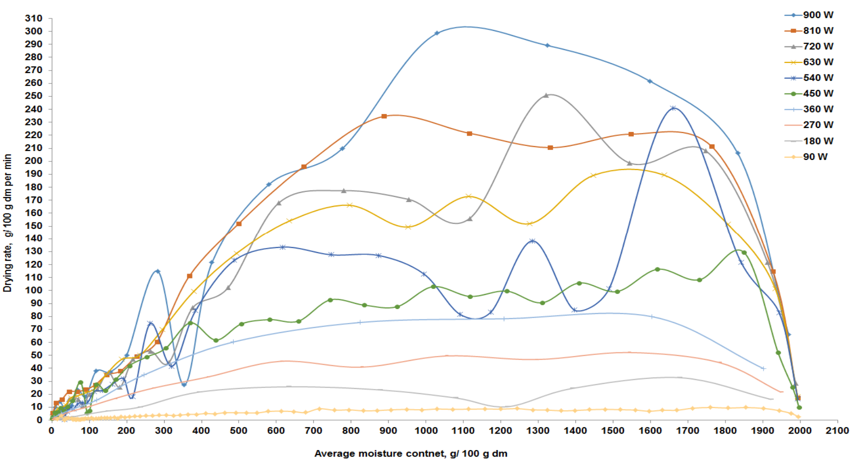

Fig 3: Variation of drying rates Vs average moisture content at different microwave power level.

during drying at lower levels of microwave powers i.e., below 360 W upto 180 W. No incidence of burning was observed during drying at microwave power of 90 W, till the final targeted moisture content of 5 to 10 % db (Table 1) was achieved.

3.6 Colour Assessment

Table 2 shows the results of colour analysis for the dried tomato powder prepared from samples dried at different microwave power levels of 900 W to 90 W. The colour characteristics (L*, a* and b*), as discussed in section 3.5, were considered as the most important quality parameter in this study in terms of the desired tomato properties, the higher L* (Lightness) and higher a* (redness) are preferred. It can be seen from Table 2 and Fig 4, that the lightness (L-value) decreases and the redness (a-value) increases as the microwave power decreases. The assessment of the colour quality can be made according to the closeness of the values of the colour parameters of the dried tomato with fresh sample. The samples dried at 180 W and 90 W microwave powers are relatively much closer to those of the fresh one, as indicated by lower values of **Δe**. However, as the incidence of burning was observed in case of sample dried at 180 W of microwave power, the samples dried at 90 W of microwave power could be preferred over others. Therefore, it can be concluded that the most preferred microwave power level is 90 W. The higher values of colour difference (**Δe**) in case of samples dried at high level of microwave powers, i.e., 900 W to 450 W, are accredited to more burning effect on samples. However, the time taken for drying was too long (420 min) as compared that required in case of higher microwave power drying.

3.7 Step by Step Decreasing Microwave Power Drying Technique

In view of aforesaid results, the improved quality of dried material can be assured by reducing microwave power level from 900 W to 90 W. The most acceptable microwave power level for drying of tomato wedges could be adjudged to be 90 W, as there was no incidence of burning during entire drying period. However, as it takes long time, i.e., nearly 420 min for drying of tomato wedges at 90 W of microwave power as compared to 20 to 35 min for drying of the same at 900 W to 450 W of microwave power. Therefore, to obtain the end product of quality comparable to that obtained by drying at 90 W of microwave power in minimum possible drying time, the feasible alternative was essentially needed to think upon. The lesser drying time could be useful for automation of drying process. Therefore, tomato wedges were tried to dry at varied microwave power, i.e., decreasing the microwave power from high level of 900 W to 90 W, step by step. Powder made on step by step decreasing microwave power was at par with 90 W. Moreover, dark spots were developed in the product due to burning at the microwave powers of 450 to 900 W. Using continuous drying of tomato wedges at every power of microwave oven i.e., from 900 W to 90 W, it could be observed that product starts to burn after some drying time, i.e., much before completion of drying of product. The first incidence of burning in case of drying of tomato wedges at each microwave power is used to decide the maximum allowable time for drying of said samples at each respective level of microwave power. According to the data base from corresponding equal moisture levels (Table 3), the microwave power level for drying was switched to subsequent lower one as shown in Fig 5, to completely avoid any incidence of burning during entire period of drying process. The time allocated for drying at different and step by step decreasing level of microwave power is mentioned in Table 3. The accumulative time required for drying using step by step decreasing microwave power level was calculated to be 80 min. The colour values (Table 4) of product obtained by this process was close (**Δe** of 6.5534 to 8.5221) to that of fresh one and product dried using 90 W of microwave power. The time required was reduced from 7 h required for drying at 90 W of microwave power to 1.33 h using step by step decreasing level of microwave powers, i.e., by nearly 80 % reduction in time of drying required. The trend of moisture ratio with time and variation in drying rate with average moisture content are in Fig 6 and Fig 7, respectively. The drying trend was found exponentially decreasing continuously. The constant drying rates observed at initial levels of higher moisture content and then followed by falling rate drying periods.

3.8 Sensory Evaluation

The sensory evaluation of the tomato soup prepared from powder of dried sample as coded (Dhumal *et al.*, 2014) in Table 5 was conducted using 9-point hedonic scale (BIS, 1971) as discussed above by the panel of untrained judges. The score given for various sensory quality attributes by judges were statistically analyzed using analysis of Variance (Montgomery, 2011, Dhumal *et al*., 2014). All the samples were found to differ significantly with respect attributed quality parameters (Table 6). It is clearly indicative from Table 2 and Fig 8, that samples dried at higher microwave power from 900 W to 540 W were of inferior quality, whereas quality improvement could be seen for samples dried at microwave power level below of 450 W upto 180 W. The highest quality was –

Table 1: Final moisture content and its corresponding drying time required

Microwave Power, W	Total drying time, min	Final Moisture content, % db
900	20	4.24919
810	21	4.167465
720	24	11.79761
630	25	4.232514
540	34	8.942767
450	36	4.016115
360	45	12.04771
270	70	9.717541
180	170	8.818171
90	420	10.60813

Table 2: Colour parameter for tomato powder

Microwave power level	Colour value			
	"L" value	"a" value	"b" value	Δe
fresh tomato	42.80	23.90	23.50	-
900 W	19.32	6.220	8.756	32.8828
810 W	13.61	9.050	9.690	35.5429
720 W	22.21	10.143	10.99	27.7435
630 W	23.76	11.950	11.88	25.3051
540 W	27.00	12.650	13.58	21.7855
450 W	33.28	18.970	18.23	11.9461
360 W	36.08	22.130	21.67	4.50779
270 W	36.55	20.670	20.20	21.8449
180 W	37.39	26.080	20.51	6.55443
90 W	39.16	29.170	21.79	6.55340

Table 3: The time allocation at each level of microwave power, by step by step decreasing levels of power

Sr. No.	Microwave power, Wt	Moisture (g per 100 g dm) levels achieved during each level of microwave power		Drying time, min	Accumulative time of drying, min
		Initial	Final		
1.	900 W	2002.000	880.628	5	5
2.	810 W	880.628	574.742	2	7
3.	720 W	574.742	420.302	1	8
4.	630 W	420.302	340.012	1	9
5.	540 W	340.012	300.134	2	11
6.	450 W	300.134	130.115	5	16
7.	360 W	130.115	175.015	5	21
8.	270 W	175.015	89.598	9	30
9.	180 W	89.598	60.044	10	40
10.	90 W	60.044	10.608	40	80

Table 4: Comparison of Color parameter for tomato powder

Microwave power level	Colour value			
	"L" value	"a" value	"b" value	Δe
Fresh tomato	42.80	23.90	23.50	-
Microwave drying at 90 W	39.16	29.170	21.79	6.55340
Step by step decreasing level of microwave power	39.30	27.970	20.04	8.52209

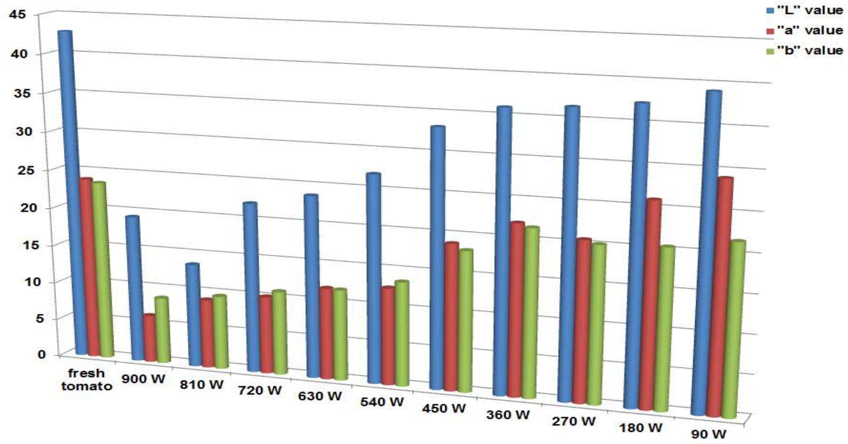

Fig 4: Variations in colour parameter of tomato powder compared with fresh tomato and step by step decreasing microwave power drying

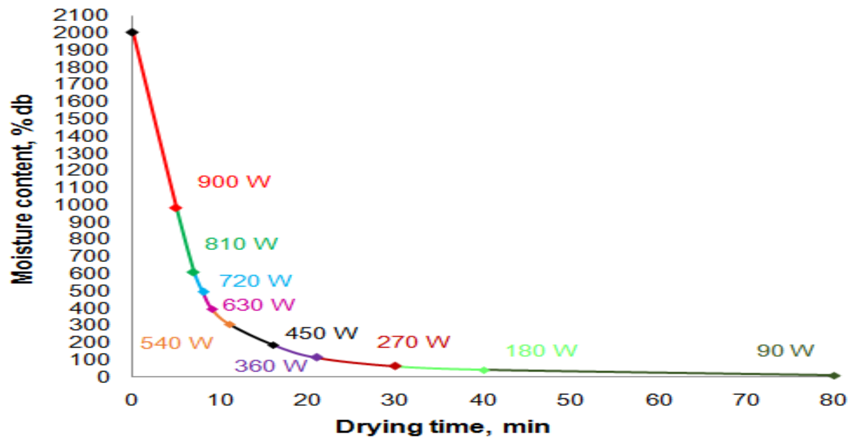

Fig 5: Moisture content Vs drying time in step by step decreasing microwave power level

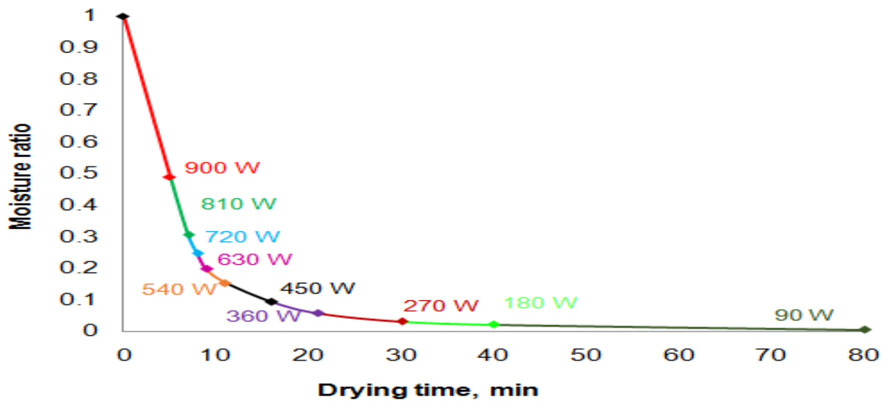

Fig 6: Moisture Ratio Vs drying time in step by step decreasing microwave power level

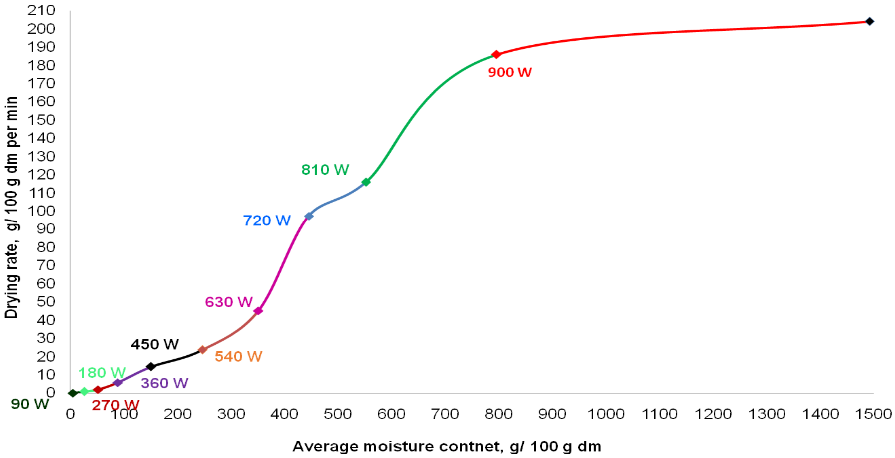

Fig 7: Drying Rate Vs Avg moisture Content of step by step decreasing microwave power drying.

Table 5: Encoding of the product considered for sensory evaluation

Product code	Name of product
A	Tomato soup prepared from tomato powder dried at 900 W
B	Tomato soup prepared from tomato powder dried at 810 W
C	Tomato soup prepared from tomato powder dried at 720 W
D	Tomato soup prepared from tomato powder dried at 630 W
E	Tomato soup prepared from tomato powder dried at 540 W
F	Tomato soup prepared from tomato powder dried at 450 W
G	Tomato soup prepared from tomato powder dried at 360 W
H	Tomato soup prepared from tomato powder dried at 270 W
I	Tomato soup prepared from tomato powder dried at 180 W
J	Tomato soup prepared from tomato powder dried at 90 W
K	Tomato soup prepared from tomato powder dried using step by step decreasing microwave power level from 90 W to 900 W.
L	Commercial tomato soup

Table 6: ANOVA for sensory evaluation

Sr. No.	Name of product	Factor means
1	Tomato soup prepared from tomato powder dried at 900 W	3.50^{a*}
2	Tomato soup prepared from tomato powder dried at 810 W	5.00^{b}
3	Tomato soup prepared from tomato powder dried at 720 W	4.25^{c}
4	Tomato soup prepared from tomato powder dried at 630 W	4.61^{bc}
5	Tomato soup prepared from tomato powder dried at 540 W	5.48^{b}
6	Tomato soup prepared from tomato powder dried at 450 W	7.27^{d}
7	Tomato soup prepared from tomato powder dried at 360 W	7.33^{d}
8	Tomato soup prepared from tomato powder dried at 270 W	7.35^{d}
9	Tomato soup prepared from tomato powder dried at 180 W	7.39^{d}
10	Tomato soup prepared from tomato powder dried at 90 W	8.50^{e}
11	Tomato soup prepared from tomato powder dried using step by step decreasing microwave power level from 90 W to 900 W.	8.52^{e}
12	Commercial tomato soup	8.13^{e}

F-Ratio = 90.27 and C.D. (5%) = 0.52293
**Values superscripted by similar letters are at par with each other.*

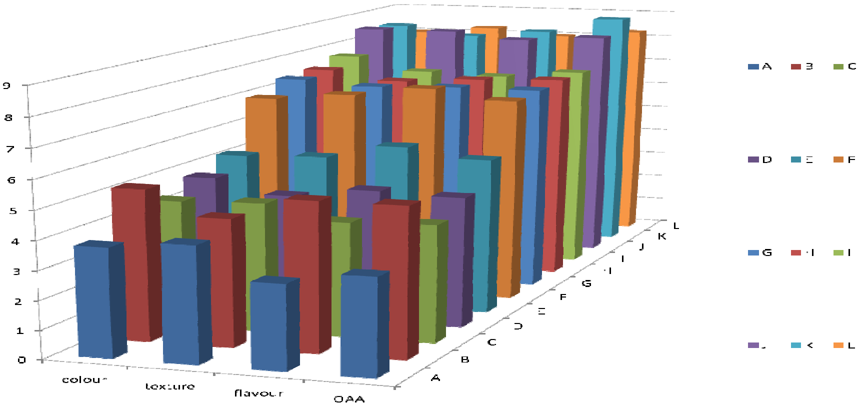

Fig 8: Sensory Evaluation of tomato soup showing marking of various factors by 12 Judges

ensured for samples dried microwave power of 90 W. The samples dried using step by step decrease in microwave power levels, as discussed above, also ensured quality of product at par of samples dried at 90 W microwave power level. These two samples were having quality at par with that obtained in case of commercially available similar product.

4. Conclusion

Ripen tomato were selected for drying and cut into tomato wedges. Drying protocol was standardized from 900 W to 90 W microwave power levels. Dried tomato wedges were ground into powder and it was analyzed for moisture, colour and sensory evaluation. It was found that drying time decreases considerably with an increase in the microwave power. Drying rate shows first an increase at all levels of microwave power and constant drying periods for considerably long period in case of drying at lower levels of microwave power below 450 W, whereas in case of higher levels of microwave power above 450 W, no considerable constant period was observed, instead, rest of the drying after initial increase, took place in falling rate period. The colour quality of the product decreases significantly with the increase of the microwave power. The step by step decreasing microwave drying technique for drying of tomato wedges from microwave power level of 900 W to 90 W gives similar quality product as dried at 90 W microwave powers and is well comparable with quality of similar commercial product. In step by step decreasing microwave drying technique for drying, the drying time (1.33 h) required is merely 20 % of that required (7 h) for drying using 90 W microwave power, ensuring at par quality product.

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