AFS- ADVANCES IN FOOD SCIENCES

Contininuation of CMTL founded by F.Drawert

Production by PSP-Vimy Str. 1e,85354 Freising,Germany in

cooperation with PRT-Parlar Research & Technology

Vimy Str 1e,85354 Freising

Printed in Germany-ISSN 1431-7737

AFS

Advances in Food Sciences(AFS) is abstracted/indexed in:

Chemical Abstract Service, BIOSIS, CAB International, Cambridge Scientific Abstracts, Food Science and Technology Abstracts(FSTA) , Current Contents/Agriculture, CSA Civil Engineering Abstracts, CSA Mechanical & Transportation Engineering,ISI(Current Contents)

CONTENTS

ORIGINAL PAPERS

A TRADITIONAL FOOD PRESERVED WITH HORSERADISH (*ARMORACIA RUSTICANA*) "GRAPE PICKLED"; MICROBIOLOGICAL AND CHEMICAL PROPERTIES

Halide Aydogdu[1,*], Safak Yildirim[1], Tunay Durgun[1], Lutfu Cakmakci[2]

[1]Arda Vocational School, Trakya University, 22100, Edirne / Turkey
[2]Department of Food Engineering, Faculty of Engineering, Ankara University, Ankara / Turkey

ABSTRACT

The grape pickled is a traditional food that preserved in cluster form of grapes by adding horseradish and imparted a characteristic unique aroma. In this study, the microbiological and chemical features of grape pickled produced in the laboratory conditions with grape varieties grown in Thrace Region were investigated. In the GC/MS analysis of horseradish roots used in grape pickled production, allyl isothiocyanate and 2-phenyl ethyl isothiocyanate were determined as the major compounds. In all of grape pickled samples, aerobic mesophilic bacteria (AMB) and lactic acid bacteria (LAB) were grown rapidly at the beginning of the fermentation, survived for a long time and then their number decreased (AMB: 5.12-8.06 log CFU/mL and LAB: 5.07-8.07 log CFU/mL for Alphonse Lavallée; AMB: 4.97-7.48 log CFU/mL and LAB: 4.58-7.47 log CFU/mL for Papazkarası). While coliform bacteria were found only in 1st-5th days of fermentation in grape pickled produced with Papazkarasi variety (0.86-4.49 log CFU/mL), Escherichia coli were not observed (<1 log CFU/mL). Also in both grape pickled, yeast and molds were rapidly inhibited with the effect of isothiocyanates. The acid amounts determined in untreated juices were increased in filling juice. There was no a significant change in the amount of reducing sugars. At all stages of production, alcohol were below the detection limit (<0.01%).

KEYWORDS:
Grape pickled, Horseradish (*Armoracia rusticana*), Microorganisms, AITC, 2-PEITC

INTRODUCTION

As in all over the world, also in Turkey, it has been increasing the interest in traditional foods due to increasing awareness for consumption of natural food products and the searching for new aromas [1]. Trakya Region which is the European part of Turkey have a variety of traditional foods as have hosted to a very different community throughout history and due to the diversity of geography. Especially, plant diversity in the area has caused to use in the production of traditional foods of these plants. The traditional foods produced depending on viticulture in the area are wine, vinegar, molasses (pekmez), dried fruit pulp (pestil), pickled leaves and less well-known hardaliye and "grape pickled".

The grape pickled is a traditional food prepared by adding treated grape juice and horseradish (*Armoracia rusticana*) roots to bunch of grapes. In this way, the grapes in clusters can be preserved intact and have a characteristic aroma. It doesn't similar to the known pickles preserved by the addition of salt and/or vinegar (acetic acid) and enriched in flavor by lactic acid fermentation. In these types of pickles are used only unripe grapes. However, grape pickled described in this study is maintained in treated grape juice (filtration, addition of protective chemicals and calcium, and heat treatment) with horseradish and is salt free. Although not contain salts, the name of this traditional food was used without changing as mentioned in the villages produced that it was "grape pickled".

Some herbs and spices have antimicrobial effects on food-borne pathogenic microorganisms and food spoilage microorganisms. These can be used instead of the protective chemicals and synthetic antibiotics as the native alternatives to prevent of bacteria and fungi growing in foods. Also the horseradish used in the production of grape pickled is a plant known antimicrobial effect belonging to family of Brassicaceae, and is used as sauce and food preservative in mostly Asia, Europe, North America and the other some countries.

In this study, the microbiological and chemical properties of grape pickles produced in the laboratory with two types of grapes, depending on traditional methods (depending on the amount of input of turban and limestone and temperature applications), were monitored during the fermentation process and grape pickle production process was evaluated. We did not have any research abroad or abroad in relation to the research topic. For this reason, verbal interviews and practices obtained from the villages where the production was made (Kırklareli province, Kızılcıkdere and Osmaniye

villages) provided the source for this study [2].

MATERIALS AND METHODS

Material. To production of grape pickled were used two different grape varieties (Alphonse Lavallée; a red aromatic grape variety and Papazkarası; blue black grape variety) grown in the Thrace Region, horseradish roots (peeled and sliced), limestone ($CaCO_3$), and sulfur, sodium benzoate and potassium sorbate as preservatives.

Production of Grape Pickled. Grape pickled were produced from the two different grape varieties under laboratory conditions using 8L glass jars. Productions were repeated three times.

Untreated juice (UJ): Bunches of grapes were washed under running water, the rotted grapes were removed. Then the grapes were processed using a crushing and destemming machine, pressed using a basket press and obtained the untreated grape juice.

Filling juice (FJ): In order to inhibition of microorganisms, 25 mg/L sulfur as potassium metabisulfite was added to the UJ. And, UJ was filtered for removal of turbidity and reduction of microbial load (Europor K 12). Then, crushed limestone containing 95.89% of $CaCO_3$ was added in ratio of1% to the juice and was left to rest for 30 minutes. This juice was heated to 90 ºC and allowed for precipitation and cooling for5 hour. The clarifying juice was taken from the top and boiled for 1-2 min. The foam occurring during boiling was removed. Then, 0.25 g sodium benzoate and 0.25 g potassium sorbate as preservatives were added in juice and again allowed to cool for collapsing of residues. The clarifying juice was taken from the top and the used as FJ.

Horseradish roots were peeled, washed and sliced into thin pieces. The horseradish pieces were used as 5% of total volume.

Bunches of grapes and horseradish root pieces were added into 8L jars and topped up with FJ and left to fermentation at room temperature. Grape pickled production was applied by described traditional techniques except for the addition of preservative chemicals and filtration.

Analysis of *Armoracia rusticana* (horseradish). GC/MS detection of major components from horseradish roots was carried out in Süleyman Demirel University (Shimadzu QP 5050 GC/MS; Libraries: Wiley, Nist, Tutor).

Analysis of Limestone ($CaCO_3$). Limestone, which is used in the production of grape pickles and contains 95.98% $CaCO_3$ was supplied from the Alpullu Sugar Factory together with the analysis reports. In this plant limestones used in calcification and saturation are obtained from stone quarries near the village where grape pickles are made.

Microbiological and Chemical Analysis. The FJ and grape pickled samples were analyzed for 40 days in terms of the aerobic mesophilic colony (Aerobic Plate Count; APC), lactic acid bacteria (LAB), coliform bacteria, *E. coli*, and the yeast and mold counts. For the microbiological analysis, the FJ and grape pickled samples were diluted using the Maximum Recovery Diluent (MRD; Merck 1.12535) at standard ratio of 1:9 to obtain suspensions within the range of 10^0 and 10^{-6} using. For the analysis of the APC, Plate Count Agar (PCA; Merck 1.05463; at 28-30ºC, 48 hours) was used. The LAB analysis was undertaken using De Man-Rogosa-Sharpe Agar (MRS; Merck 1.10660; at 28-30ºC, 48hours) and the analysis of coliform group bacteria and *E. coli* was carried out using VRB Agar and Chromocult TBX Agar (Merck 1.16122; at 37ºC, 24 hours). For the analysis of the yeast-mold, Rose Bengal Chloramphenicol Agar (RBC; Merck 1.00467; at 28-30ºC, 5 days) was used [3]. The average values were calculated from the three repeats of the tests and the results were given as log CFU/mL.

The chemical analysis of UJ, FJ and grape pickled samples consisted of determining; the total acidity (using titration method and g/L as tartaric acid), pH (using Hanna HI 221 model pH meter), water-soluble dry matter (Brix) (using Soif WYA Abbe refractometer), ash [4], sugar (with DNS method using Mecasys Optizen POP UV/VIS spectrophotometer at 522 nm) [5] and alcohol (using EON Trading electronic Ebulliometer, in %). The results for the chemical analysis were also given as the average of the three repetitions for each grape type.

RESULTS AND DISCUSSION

Many studies have reported that horseradish contains glucosinolates (GLS) [6-8] and that the main products of hydrolysis of GLS with the myrosinase enzyme are isothiocyanates (ITCs) [7-10]. Allyl isothiocyanate (AITC) and 2-phenylethyl isothiocyanate (2-PEITC) are ITCs most commonly found in horseradish [6,8,11-14]. In GC/MS analysis of horseradish roots used in this study, both substances were also found (Fig 1). According to the analysis results; the main components of horseradish roots were AITC (8.25%, r.t.:27.9), 2-PEITC (14.43%, r.t.:79.31) and phythol (77.32%, r.t.:80.54) (in chloroform extracts). In addition to horseradish, ITCs also found in plants such as mustard, broccoli, Brussels sproutsh have antibacterial and antifungal effects [9,10, 12,15-17].

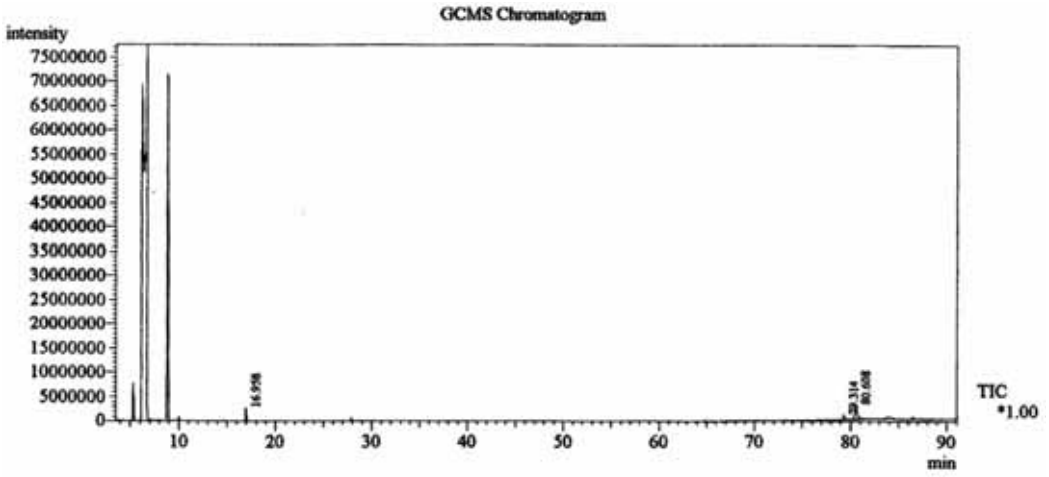

FIGURE 1
GC-MS analysis of horseradish roots (Libraries: Wiley, Nist, Tutor)

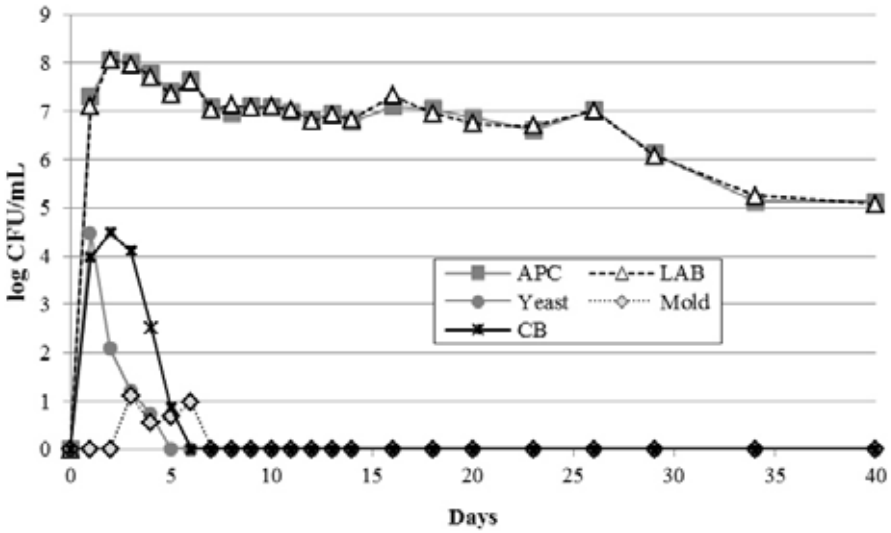

FIGURE 2
The microbiological features (log CFU/mL) of grape pickled prepared with Alphonse Lavallée grape variety (Day 0: FJ)

No microorganisms were found in FJ used in the production of grape pickles. According to this; all of the microorganisms found in the analyzes made on the first day of production came from grape, horseradishe, and environment. The low level of competitive microorganisms in the environment due to the absence of microorganisms in FJ has facilitated the rapid growth of lactic acid bacteria on grape clusters. On the second day of fermentation in grape pickled prepared with Alphonse Lavallée grape varieties and on the third day of fermentation in grape picled prepared with Papazkarası grape varieties, AMB and LAB numbers were found to be highest in Alphonse Lavallée (AMB; 8.06 log CFU/mL and LAB; 8.07 log CFU/mL for Alphonse Lavallée; AMB; 7.48 log CFU/mL and LAB; 7.47 log CFU/mL for Papazkarası). In both grape varieties, the AMB and LAB numbers remained almost constant after this increase. For this reason; it is believed that the AMB and LAB numbers reached on the 2nd and 3rd day of fermentation are the highest numbers that can be approximately found as the capacity in mL of FJ. The numbers of TMAB and LAB decreased after 26th day of fermentation in the Alphonse Lavallée variety and after 13th day in the Papazkarası variety (Figure 2,3).

To the increase and decrease in parallel of TMAB and LAB numbers in both types of grape pickled were showed that bacterial flora were consisted substantially of LAB. Several studies have reported that ITCs showed stronger antimicrobial activity against Gram-negative bacteria than Gram-positive bacteria [18-21]. And lactic acid bacteria are more resistant to ITCs [19]. Pérez-Díaz & McFeeters [22] showed that allyl isothiocyanate did not prevent growth of *Lactobacillus plantarum*. The presence of lactic acid bacteria in the grape pickled can be confirmed by this information. However, more research is needed on the inhibition of various Gram-positive, Gram-negative and lactic acid bacteria in various ITCs concentrations.

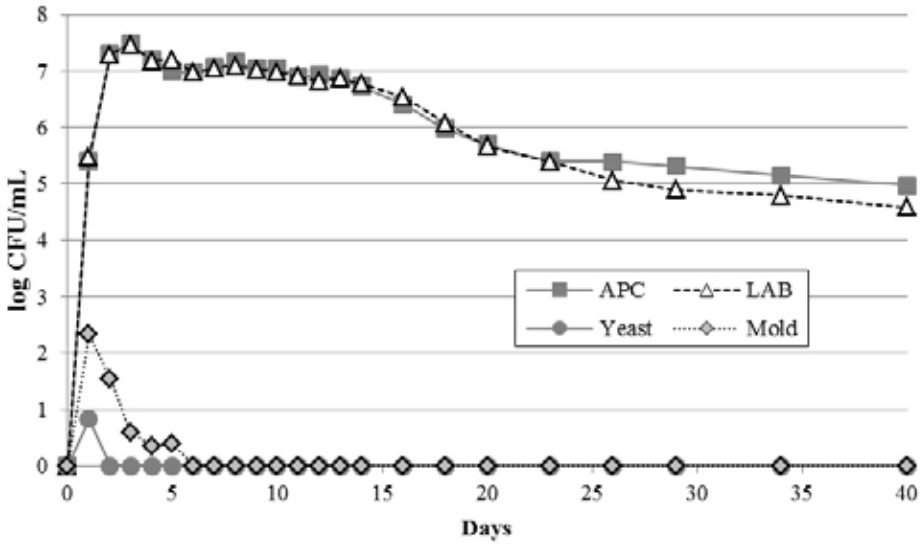

FIGURE 3
The microbiological features (log CFU/mL) of grape pickled prepared with Papazkarası grape variety (Day 0: FJ)

The coliform bacteria and *E.coli* (<1 log CFU/mL) were not observed in Papazkarası grape pickled samples. In Alphonse Lavallée grape pickled samples, coliform bacteria were determined in the first 5 days of fermentation. The numbers of CB rapidly decreased until from 2nd days to 5th days of fermentation and below the detection limit (<1 log CFU/mL) (Fig 2). It is thought that CB can be contaminated from the raw material, personnel and environment during production. However, these bacteria did not survive due to the inhibitory effect of ITCs coming from horse radish. The inhibitory effect on *E. coli* of ITC compounds is already widely known [17,23-24]. Similarly, yeast and molds were also inhibited shortly (<1 log KOB / mL), although in all experiments they were seen at the beginning of fermentation (<1 log CFU/mL) (Fig 2 and 3). Because, also the antifungal effects of ITCs are known [14,25-26].. In Alphonse Lavallée grape pickled samples, absence of molds in first 2 days but presence in 3rd-6th days showed a possible contamination.

Preparation of FJ used in the production of grape pickles is a simple form of preparation of must which is concentrated in the production of "grape pekmez", another traditional food [27]. Because of this similarity and absence of quality criteria for grape pickled, the chemical results for FCs were evaluated by comparing with must of grape pekmez; and chemical analyses results were shown in Fig 4.

The preparation of FJ used in the production of grape pickles is similar to some of the production steps of grape molasses [27], another traditional product. Because of this similarity and the absence of a known quality criteria for grape pickles, chemical evaluations for FJs have been made by associating with the must in the molasses production; and chemical analyses results were shown in Fig 4.

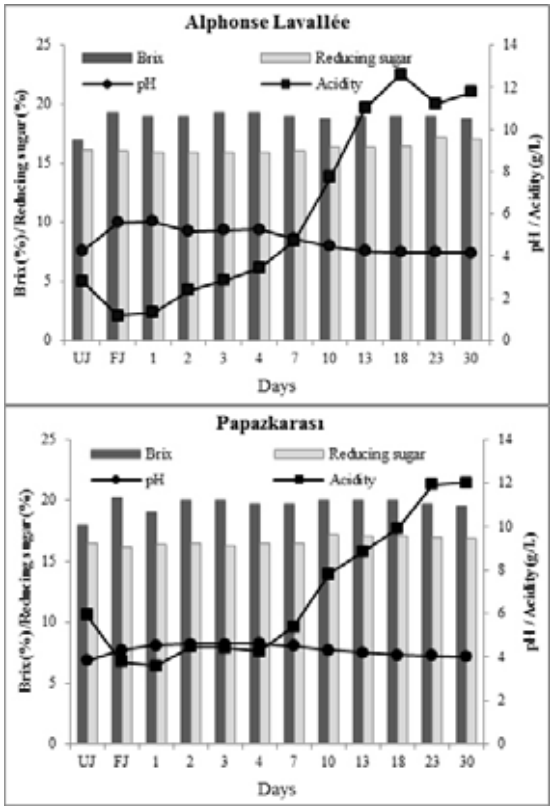

FIGURE 4
The results of chemical analysis belonging to UJ, FJ and grape pickled prepared with Alphonse Lavallée and Papazkarası grape varieties

For Alphonse Lavallée and Papazkarası grape varieties pH values were 4.24 and 3.82 at UJs; were 5.57 and 4.32 at FJs prepared from same juices, and it continued to decrease until 4.15 and 3.99 during the fermentation period. While acidity of UJs were

2.80 and 5.93 g/L, at FJs were fell to 1.18and 3.79 g/L; these values gradually increased and reached 11.76 and 12.02 at the end of fermentation (Fig 4). The addition of limestone is beneficial in removing acidity of the must, collapsing some colloids and clarifying the must depending on contained amount of $CaCO_3$. The applied heat treatments increase the activity of the limestone incorporated [28].

In this study, reduction in the total acid was 1.62 g/L and 2.14 g/L for Alphonse Lavallée and Papazkarası varieties. According to the Official Statement of grape pekmez, pH must be <5.0-6.0 for sweet pekmez and 3.5-5.0 for sour pekmez (not reduced acidity) [27]. Accordingly, with 5.57 pH value Alphonse Lavallée FJ were complied with juice prepared for sweet pekmez.

Whereas, in the Papazkarası FJ the acid removal process was inadequate and remained within the pH limits specified for the juice prepared for sour pekmez. Therefore, in the Papazkarası experiments, stone formation from tartaric acid was observed on grape grains and at the bottom of the jars. For this reason, the amount of $CaCO_3$ to be added to remove acidity and the duration of heat treatment are important (0,5-1%) [29], otherwise extra operations will be required to remove tartaric acid stones.

For both grape varities, initially determined Brix values (17.00% for Alphonse Lavallée, 18.00% for Papazkarası) increased slightly in FJs (19.25% and 20.25%) and these values did not show a significant change during the trial. Also, no significant change in the amount of reducing sugars determined in UJ during fermentation was detected (Figure 4). Still, a point to be emphasized is amounts of carbohydrates and dry matters involved to juice with 5% horseradish roots.

In filling juices and all grape pickled samples during fermentation, alcohol were below the detection limit (<0.01%). Preventing of yeast development with the addition of sulfur, protective chemicals (sodium bensoate and potassium sorbate) and horseradish roots has explained absence of alcohol.

It has been determined that the grain grapes retained their hardness in the grape pickles produced in laboratory scale. However, in particular, the wine stone crystals observed in Papazkarası should be regarded as a problem in the production of grape pickles as well as in grape juice technology and necessary measures should be taken to clarify and remove the wine stones [30].

CONCLUSION

The grape pickled that is important for domestic economic and produced with local techniques has been freshly consumed. In order to extend the shelf life of grape pickled in the industrial production should be done further researches on the microbiological and technological features such as controlled fermentation with starter cultures, modern techniques of pekmez and grape juice (depectinization, fining, filtration of protein and elimination of wine stone etc), clove and ginger like aroma contributions. To control of the product color, the pomace should be macerated and standardization should be achieved. Further research is also needed to determine the optimum concentrations of horseradish and its ITCs content. Grape pickled also can be considered as an important product because there are studies indicating that is have anticancer properties of the ITC in horseradish root is used in its production [14,31]. Due to inaccessibility of any study on grape pickled, it has been also believed that this study can shed light on future studies.

ACKNOWLEDGEMENTS

This study was supported by Trakya University, Project code of BAP-131. Also, we thanks to Prof. Dr. Tuna Ekim and Prof. Dr. Murat Ekici for identification of horseradish plant (*Armoracia rusticana*).

REFERENCES

[1] Albayrak, M. and Güneş, E. (2010) Traditional foods: Interaction between local and global foods in Turkey. African Journal of Business Management. 4, 555-561.

[2] Aydoğdu, H., Gucer, Y., Cakmakci, L. and Durgun, T. (2010) A traditional Thracian food: "grape pickled" Proceedings of The 1st International Symposium on "Traditional Foods from Adriatic to Caucasus" 15-17 April, Tekirdağ, Turkey, pp 963.

[3] Anonymous (2005) Merck Gıda Mikrobiyolojisi Uygulamaları. Ed: Halkman, A.K. Başak Matbaacılık Ltd. Şti., Ankara.

[4] Cemeroğlu, B. (2007) Gıda analizleri, Gıda Teknolojisi Derneği Yayınları No:34, Ankara.

[5] Miller, G.L. (1959) "Use of dinitrosalicylic acid reagent for determination of reducing sugar". Anal. Chem. 31, 426.

[6] Shofran, B.G., Purrington, S.T., Breidth, F. and Fleming, H.P. (1998) Antimicrobial properties of sinigrin and its hydrolysis products. Journal of Food Science. 63, 621-624.

[7] Yu, E.Y., Pickering, I.J., George, G.N. and Prince, R.C. (2001) In situ observation of the generation of isothiocyanates from sinigrin in horseradish and wasabi. Biochimica et Biophysica Acta. 1527, 156-160.

[8] Shin, S., Han, J., Choi, K., Chung, D., Choi, G., Ahn, J. (2010) Effect of isothiocyanates from horseradish (*Armoracia rusticana*) on the quality and shelf life of tofu. Food Control. 21, 1081-1086.
[9] Matsuda, H., Ochi, M., Nagatomo, A. and Yoshikawa, M. (2007). Effects of allylisothiocyanate from horseradish on several experimental gastric lesions in rats. European Journal of Pharmacology. 561, 172–181.
[10] Mushantaf, F., Blyth, J. and Templeton, M.R. (2012) The bactericidal effects of allylisothiocyanate in water. Environmental Technology. 33, 2461–2465.
[11] Velioglu, Y.S., Mazza, G., Gao, L. and Oomah, B.D. (1998) Antioxidant activity and total phenolics in selected fruits, vegetables, and grain products. J. Agric. Food Chem. 46, 4113-4117.
[12] Hara, M., Oda, M., Yogo, T., Sumi, T., Arai, R., Kuboi, T. and Etoh, H. (2008) detection of horseradish (*Armoracia rusticana*) myrosinase genes in samples containing horseradish. Food Sci. Technol. Res. 14, 389-394.
[13] Jung, D.C., Lee, S.Y., Yoon, J.H., Hong, K.P., Kang, Y.S., Park, S.R., Park, S.K., Ha, S.D., Kim, G.H., and Bae, D.H. (2009) Inhibition of pork and fish oxidation by a novel plastic film coated with horseradish extract. LWT - Food Science and Technology. 42, 856–861.
[14] Nguyen, N.M., Gonda, S. and Vasas, G. (2013) A review on the phytochemical composition and potential medicinal uses of horseradish (*Armoracia rusticana*) root. Food Reviews International. 29, 261–275.
[15] Mucete, D., Borozan, A., Radu, F. and Jianu, I. (2006) Antibacterial activity of isothiocyanates, active principles in *Armoracia rusticana* roots (I). Journal of Agroalimentary Processes and Technologies. 12, 443-452.
[16] Tajkarimi, M.M., Ibrahim, S.A. and Cliver, D.A. (2010) Antimicrobial herb and spice compounds in food. Food Control. 21, 1199–1218.
[17] Dufour, V., Stahl, M. and Baysse, C. (2015) The antibacterial properties of isothiocyanates. Microbiology. 161, 229-243.
[18] Shin, I.S. and Lee, J.M. (1998) Study on antimicrobial and antimutagenic activity of horseradish (*Wasabia japonica*) root extracts. J. Korean Fish Society. 31, 835-841.
[19] Bhat, R., Alias, A.K. and Paliyath, G. (2012) Progress in food preservation. John Wiley & Sons Publication.
[20] Park, S.Y., Barton, M. and Pendleton, P. (2012) Controlled release of allyl isothiocyanate for bacteria growth management. Food Control. 23, 478-484.
[21] Davidson, P.M., Bozkurt Cekmer, H., Monu, E.A. and Techathuvanan, C. (2015) "The Use of Natural Antimicrobials in Food" in Handbook of Natural Antimicrobials for Food Safety and Quality. edited by M. Tylor. Woodhead Publishing.
[22] Pérez-Díaz, I.M. and Mcfeeters, R.F. (2010) Preservation of acidified cucumbers with a natural preservative combination of fumaric acid and allyl isothiocyanate that target lactic acid bacteria and yeasts. J. Food Sci. 75, 204-208.
[23] Hu, S.H., Wang, J.C., Kung, H.F., Wang, J.T., Lee, W.L. and Yang, Y.H. (2004) Antimicrobial effect of extracts of cruciferous vegetables. Kaohsiung J. Med. Sci. 20, 591-599.
[24] Lucera, A., Costa, C., Conte, A. and Nobile, M.A.D. (2012) Food applications of natural antimicrobial compounds. Frontiers of Microbiology. 3, 1-13.
[25] Isshiki, K,, Tokuoka, K,, Mori, R, and Chira, S, (1992) Preliminary examination of allyl isothiocyanate vapor for food preservation. Biosci. Biotech. Biochem. 56, 1476-1477.
[26] Depree, J.A., Howard, T.M. and Savage, G.P. (1999) Flavour and pharmaceutical properties of the volatile sulphur compounds of Wasabi (*Wasabia japonica*). Food Research International. 31, 329-337.
[27] Anonymous (2007) Türk Gıda Kodeksi, Pekmez Tebliği, Tebliğ No:2007/27, Resmi Gazete, Sayı: 26553, 15.06.2007.
[28] Batu, A. and Aktan, N. (1992) Kuru üzümlerden pekmez yapılmasında şıraya uygulanan asit gidericilerin miktarı üzerine bir araştırma. Gıda. 17, 143-150.
[29] Karakaya, M. and Artık, N. (1990) Zile Pekmezi Üretim Tekniği ve Bileşim Unsurlarının Belirlenmesi. Gıda. 15, 151-154.
[30] Cemeroğlu B and Karadeniz F (2001) Meyve Suyu Üretim Teknolojisi. Gıda Teknolojisi Derneği Yayınları. No: 25. Ankara.
[31] Zhang, Y. (2010) Allyl isothiocyanate as a cancer chemopreventive phytochemical. Mol Nutr Food Res. 54, 127-35.

Received: **16.07.2018**
Accepted: **23.09.2018**

CORRESPONDING AUTHOR

Halide Aydogdu
Trakya University,
Arda Vocational College,
22030 Edırne

e-mail: halideaydogdu@trakya.edu.tr

EFFECTS OF DIFFERENT GARLIC FORMS ON TURKISH SUCUK QUALITY

Recep Kara*, Ulas Acaroz, Zeki Gurler, Yagmur Nil Demirel, Mehmet Naci Salim

Afyon Kocatepe University, Faculty of Veterinary Medicine, Department of Food Hygiene and Technology, Afyonkarahisar, Turkey

ABSTRACT

Sucuk (Turkish type sausage) is a popular and one of the most consumed meat product in Turkey. Efforts to determine the antibacterial properties of some plants or extracts and different forms of them are ongoing. Garlic contributes to sucuk production as an antibacterial agent and as an additive for the formation of flavour and aroma. In this study, the possibility of using different garlic forms (clove of garlic, oil, powder) in sausage production has been investigated. For this purpose, the sucuk dough was prepared and divided into three groups. Clove of garlic (Group A), garlic oil (Group B) and garlic powder (Group C) were added to these groups, respectively and the prepared dough filled into collagen casings. It was then fermented and taken during the fermentation period on 0, 3rd, 7th, 12th days. On the same days, total aerobic mesophilic bacteria, lactic acid bacteria, yeast/ mould and coliform bacteria counts, pH determination and moisture determination analyses were performed. At the end of the fermentation (day 12th), sensory examination of sucuk samples was carried out. The results of the study at the 12th day showed that difference between groups (A, B, C) was not statistically significant ($p>0.05$) regarding TAMB (7.39-7.65); LAB (7.15-7.59); and yeast/ mould (4.06-4.35); pH (4.99-5.09); Humidity (36.76-37.30). The sensory examination points of the sucuk samples ranged from 7.50 to 7.90 ($p>0.05$).

Consequently, no significant difference was found between the effects of garlic forms (clove of garlic, oil, powder) on the fermented sucuk quality. Thus, it is suggested that one of the three garlic forms that is the easiest to find for producers can be used for sucuk production.

KEYWORDS:
Sucuk, Garlic, Fermentation, Meat Products

INTRODUCTION

Sucuk (Turkish type sausage) is one of the most popular meat products in Turkey. It is composed of beef, sheep or buffalo meat, fat, salt (nitrite), sugar, garlic and mixture of some spices [1]. Sucuk produced in Turkey are classified into two groups as fermented sucuk and heat treated sucuk [2, 3]. Fermented sucuk is mostly prefered by consumers due to the effect of fermentation on the flavour, aroma, colour and structural qualities of these products [4]. Antimicrobial additives are compounds added to foods in order to prevent them from pathogens and non-pathogen microorganisms [5]. Antimicrobial compounds in spices (eugenol, thymol etc.) are particularly effective on gram-positive bacteria and moulds. Also, the addition of spices in the mixture increases the antimicrobial effect [6]. Recently, natural food additives are used to control the foodborne pathogen. Moreover, the effect of plant extracts on bacteria is studied in detail in different parts of the world [7].

Garlic (*Allium sativum L.*) is a plant from onion family that is used as food, spice and medicine in different parts of the world. Garlic has been demonstrated to have antiviral, antibacterial and antifungal effects [8].

Garlic is used in sucuk production because of its antimicrobial effect and organoleptic properties. The present study aimed to investigate the effects of different garlic forms (clove of garlic, oil, powder) on the quality of sucuk.

MATERIAL AND METHOD

Preparation of Sucuk Samples. Sucuk dough was prepared according to Gökalp ve ark. [5] with some modifications. According to this formulation it consisted of 80% beef, 20% fat and mixture of spices (2% salt, 0.6 sugar, 0.7% red pepper, 0.5% black pepper, 0.9% cumin and 0.25% allspice). Then the sucuk dough was divided into three groups and three different garlic forms (Group A: 0,7% clove of garlic, Group B: 0,001% garlic oil and Group C: 0,25% garlic powder) were added.

Prepared sucuk dough was filled into collagen intestine casings (32 mm Naturin Darm). Sucuk samples were fermented at 22-25°C with 80-90% relative humidity until day 12.

Analysis of Sucuk Samples. Sucuk samples were taken for microbiological analysis at 0, 3rd, 7th, and 12th days. The number of total mesophilic bacteria [9], lactic acid bacteria [10, 11], yeast/

mould and coliform bacteria [12] were determined. pH analysis [13] and relative humidity analysis [14] were performed in sucuk samples.

Sensory Examination. Sensory evaluation of the samples was done by 10 panellists. The panellists evaluated sucuk samples in terms of their cross-section colour and appearance, taste and aroma, texture, and general appreciation. Panelists used hedonic scales ranging from 1-3 (very bad - not acceptable), 4-5 (moderate), 6-7 (good), 8-9 (very good).

Statistics analysis: The data were analyzed by SPSS statistical package program.

RESULT AND DISCUSSION

The results of the microbiological analysis of sucuk samples produced with clove of garlic, garlic oil and garlic powder are shown in table 1.

At the end of fermentation in sucuk samples, no significant difference was observed in the total aerobic bacteria counts among the groups (P>0.05). However, at the beginning of fermentation, total aerobic bacteria number is approximately log 6 CFU/g levels while bacteria number increases to approximately log 7 CFU/g at the fermentation process. Similarly, Bozkurt [15] reported that total aerobic bacteria counts as 5,5 log CFU/g at the beginning of fermentation and 6,5 – 7,5 log CFU/g at the end of the fermentation.

At the end of fermentation, there was no difference between groups regarding their lactic acid bacteria count (P>0.05). But until the end of fermentation, the lactic acid bacteria increased in numbers from log 1-2 CFU/g to log 7 CFU/g. Lactic acid bacteria increase in numbers on fermented meat products, especially on sucuk, and next they ferment the sugar to the lactic acid [5]. In this experiment, the number of lactic acid bacteria increased which is similar to other experiments [1, 16].

On the last day, there was no significant difference between groups regarding their yeasts and moulds number (P>0.05). Until finish of fermentation the lactic acid occurred during fermentation, influence to decline in a number of the yeasts and moulds. In this process, the yeasts and moulds declined in number log 1 CFU/g.

At the beginning of the fermentation, the level of coliform bacteria in experimental groups was approximately log 3 CFU/g, but after fermentation, the number of the coliform bacteria declined to <log 2,30 CFU/g. End products should not contain coliform bacteria, because they are known as hygiene indicators. Finally, in this experiment, the number of coliform bacteria was detected as <log 2,30 CFU/g.

The pH and moisture values of the different groups have been shown in table 2.

TABLE 1
Microbiological Analysis Result of Sucuk Samples

Microbiological Analysis	Groups	0	3	7	12
	A	6,75^{a}	7,30^{b}	7,43^{b}	7,39^{a}
Total Aerob Mesophilic Bacteria	B	6,90^{a}	7,39^{ab}	7,59^{ab}	7,60^{a}
	C	6,64^{a}	7,69^{a}	7,70^{a}	7,65^{a}
	A	5,45^{b}	6,30^{b}	7,47^{a}	7,15^{a}
Lactic Acid Bacteria	B	6,81^{a}	7,36^{a}	7,57^{a}	7,59^{a}
	C	6,57^{a}	7,49^{a}	7,46^{a}	7,20^{a}
	A	5,51^{a}	4,61^{b}	4,20^{a}	4,06^{a}
Yeast / Mould	B	5,63^{a}	4,86^{a}	4,47^{a}	4,35^{a}
	C	5,73^{a}	4,80^{a}	4,62^{a}	4,29^{a}
	A	2,80^{a}	<log 2,30	<log 2,30	<log 2,30
Total Koliform	B	2,75^{a}	<log 2,30	<log 2,30	<log 2,30
	C	2,95^{a}	<log 2,30	<log 2,30	<log 2,30

A: clove of garlic, B: garlic oil, C: garlic powder;
^{a,b} (↓)Means in the same column with different letters shows a significant difference ($p < 0.05$).

TABLE 2
The result of pH and Humidity of Sucuk Samples

Analysis	Groups	0	3	7	12
	A	5,78^{a}	5,01^{a}	5,66^{a}	5,09^{a}
pH	B	5,60^{b}	5,06^{a}	5,00^{b}	4,99^{b}
	C	5,70^{ab}	4,96^{a}	5,03^{ab}	5,08^{a}
	A	57,24^{c}	49,96^{b}	46,02^{a}	37,02^{a}
Humidity (%)	B	59,16^{b}	50,05^{ab}	45,16^{c}	36,76^{a}
	C	60,45^{a}	52,22^{a}	45,40^{b}	37,30^{a}

A: fresh garlic, B: garlic oil, C: garlic powder
^{a,b,c} (↓)Means in the same column with different letters shows a significant difference ($p < 0.05$)..

TABLE 3
Sensory Analysis Result of Sucuk Samples

Groups	Appearance	Bad Smell	Taste	Colour	Texture	General
A	7,20	6,70	6,60	6,60	6,00	7,50
B	6,90	6,40	6,60	6,70	6,30	7,90
C	7,40	7,30	6,60	6,60	6,80	7,74

A: fresh garlic, B: garlic oil, C: garlic powder, ($p < 0.05$).

At the end of the experiment, there was a significant difference between group B and A regarding their pH level ($P<0.05$). During the fermentation, the number of the lactic acid bacteria increased which is resulted in the decline of pH level (4.99-5.09). The pH value of the sucuk samples was in accordance with the level determined by the Turkish Food Codex [3].

No difference was detected between groups regarding their moisture level at the end of the experiment. ($P>0.05$). During the experiment, the moisture level of sucuk samples was declined due to water loss and desiccation. Finally, in the last product, the moisture was detected between 36.76% and 37.30%. The results of the present study were in line with the previous reports regarding the moisture level [16, 17].

The sensory quality of sucuk samples was shown in table 3. There was no significant difference on the 12th day between the experimental groups about sensory parameters including appearance, bad smell, taste and colour, texturing and general appreciation. The points of general appreciation for all three groups were determined as higher than seven.

Garlic possesses anti-fungal, anti-bacterialü antioxidant properties and has an effect on the taste and flavour of foods. Also, the garlic is produced in the different forms such as dried garlic, garlic oil, garlic salt, encapsulated garlic, garlic juice/extract [8, 18].

At the end of the experiment (12th day), there was no significant difference between groups (A, B, C) regarding their pH (4,99-5,09); moisture (36,76-37,30); TAMB (7,39-7,65); LAB (7.15-7.59); yeast/mould (4.06-4.35); general appreciation (7.50-7.90) ($p>0.05$). According to the results of the experimental analysis, the different garlic forms do not affect the quality of sucuk.

CONCLUSION

In conclusion, garlic oil is an expensive food product, but if it is compared to other garlic products used in sucuk production, the garlic oil may be accepted as economic. Because the garlic oil is used in very low quantities (0.001%) in the production of sucuk. Also, the storage of the garlic oil is easier compared to other garlic forms due to its need for smaller space. Finally, it was determined that there were no significant effects of different garlic forms on the properties of the fermented sucuk. Therefore, it is suggested that one of the three garlic forms (clove of garlic, garlic oil, garlic powder) especially garlic oil can be employed for sucuk production which are easy to obtain and storage.

ACKNOWLEDGEMENTS

This study was supported by a grant from the Afyon Kocatepe University Scientific Research Council, Afyonkarahisar, Turkey (Project no: 15.VF.ALTY.02) and was presented as abstract in 4nd International VET Istanbul Group Congress, Almaty, Kazakhstan.

REFERENCES

[1] Aksu, M.I., Kaya, M. (2004). Effect of usage Urtica dioica L. on microbiological properties of sucuk, a Turkish dry-fermented sausage. Food Control, 15(8), 591-595.

[2] Yıldırım, Y. (1996). Et Endüstrisi, Uludağ Ü. Veteriner Fak., Kozan Ofset (4. Baskı), Ankara).

[3] TFC, 2017 Turkish Food Codex, Meat and Meat Products, (Number: 2012/74)

[4] Pehlivanoğlu, H., Nazli, B., Imamoğlu, H., Çakir, B. (2015): Determination of the Quality Characteristics of Products As Sold Under Fermented Sausage Products in the Market and the Comparison with a Traditional Turkish Fermented Sausage (Sucuk)". Journal of The Faculty of Veterinary Medicine Istanbul University 41(2), 191-198.

[5] Gökalp H.Y., Kaya M. ve Zorba Ö. (2002). Et Ürünleri İşleme Mühendisliği, Atatürk Üniversitesi Ziraat Fakültesi Ofset Tesisi, Erzurum.

[6] Liu, Q., Meng, X., Li, Y., Zhao, C.N., Tang, G.Y., Li, H.B. (2017). Antibacterial and Antifungal Activities of Spices. International Journal of Molecular Sciences. 18(6), 1283. Hseieh, P. C., Mau, J. L., Huang, S. H. (2001). Antimicrobial effect of various combinations of plant extracts. Food Microbiology. 18:35-43.

[7] Singh V.K., Singh D.K. (2008). Pharmacological Effects of Garlic (Allium sativum L.), Annual Review of Biomedical Sciences,10:6-26.

[8] ISO (2003). International Standart Organisation (ISO 4833). Horizontal Method for the Enumeration of Microorganism. Colony Count Technique at 30^0C.
[9] Lopez-Diaz, T.M., Alonso, C., Roman, C., Garcia Lopez, M.L., Moreno, B. (2000). Lactic acide bacteria isolated from a hand made blue cheese. Food Microbiol. 17: 23-32.
[10] Coppola, R., Succi, M., Sorrentino, E., Iorizzo, M., Grazia, L. (2003). Survey of lactic acid bacteria during the ripening of Caciocavallo cheese produced in Molise. Lait, 83: 211-222.
[11] Pichhardt, K. (1993). Lebensmittel-Mikrobiologie, Springer Verlag, Berlin.
[12] TS 3136 ISO 2917. (2002). Meat and Products-Measurement of pH-Reference Method.
[13] TS 1743 ISO 1442. (2001). Meat and meat-Products Determination of moisture content (Reference Method).
[14] Bozkurt, H. (2002). Effects of some storage conditions and additives on quality and stability of Sucuk (Turkish dry-fermented sausage), Ph D thesis, Gaziantep University, Institute of Natural and Applied Sciences, Gaziantep, Turkey.
[15] Soyer, A., Ertas, A.H., Üzümcüoglu, Ü. (2005). Effect of processing conditions on the quality of naturally fermented Turkish sausages (sucuks). Meat Science, 69; 135-141.
[16] Erçoşkun, H. (2006). Effects of fermentation time on some quality characteristics of heat processed sucuks. Ph D thesis. Ankara University, Graduate School of Natural and Applied Sciences, Ankara, Turkey.
[17] Çakmakçı S, Gündoğdu E. (2005). Garlic: Components and Effects on Food and Human Health. Gıda ve Yem Bilimi Teknolojisi, 8, 20-29.

Received: **03.07.2018**
Accepted: **22.09.2018**

CORRESPONDING AUTHOR

Recep Kara
Afyon Kocatepe University, Faculty of Veterinary Medicine, Department of Food Hygiene and Technology, Afyonkarahisar, Turkey

e-mail: recepkara83@gmail.com

EFFECT OF INULIN AND CARRAGEENAN AS A FAT REPLACER ON PHYSICOCHEMICAL, COLOR AND SENSORY PROPERTIES OF HEATED-SAUSAGE

Masoume Salajegheh, Seyed Ali Yasini Ardakani*, Mohammad Daneshi

Department of Food Science and Technology, College of Agriculture, Islamic Azad University, Yazd Branch, Yazd Iran.

ABSTRACT

The present investigation was done to study the effect of inulin and carrageenan as fat replacer on physicochemical and sensory properties of sausage. Studied treatments were including treatments with 2.92% inulin, 5.84% inulin, 2.92% carrageenan, 5.84% carrageenan, 1.46% inulin and carrageenan and 2.92% inulin and carrageenan. After preparation of samples, physicochemical, color and sensory tests were done. Removing fat from the formulation caused to increase in the moisture and reduce the amount of protein, ash, and fat. Increasing in the levels of inulin and carrageenan caused to increase in the amount of moisture. The lowest amount of fat was related to the treatment of 5.84% inulin (6.21%). Replacement caused increase in the levels of proteins. Replacement was also caused to incensement of the levels of ash. Removal of fat caused decrease in the L factor, incensement of a and decrease of b. Treatment contain 2.92% inulin and 2.92% carrageenan had the highest sensory scales but it had no significant difference with other treatments for the appearance. Its hope that measures be taken to see production of sausage samples without harmful fat using inulin and carrageenan replacements in meat products industry of country.

KEYWORDS:
Sausage, Inulin, Carrageenan, Fat replacement, Physicochemical properties, Color properties, Sensory evaluation.

INTRODUCTION

The demand for meat products with lower fat contents has increased in recent years due to new guidelines recommending reduced saturated fat intake and consumers' desire to lose weight [1, 2]. Several alternative strategies have been developed for production of low fat meat products of which substitution of saturated fat with several types of fat replacer has the best effects [1-3]. Several investigations have been suggested the considerable effects of substitution of saturated fat of the meat products with fat replacers such as carrageenan, inulin, guar and xanthan gums [1-4].

Inulin is a soluble plant fiber that consists of a mixture of oligo- and polysaccharides [5]. Inulin can be used as a fat replacement in food products due to its ability to form a gel when mixed with water. The resulting gel has a fine, creamy texture that mimics the oral tactile sensation of fat in products with low fat content [6, 7]. At the same time, inulin contributes few calories to food products, approximately 1 to 1.5 kcal/g [6, 7].

Carrageenans is a sulphated polysaccharides extracted from red seaweed (marine algae of the class Rhodophyta) which can increase viscosity, provide mouthfeel and texturize of the food products [8-10]. Carrageenans, mainly κ and ι-carrageenan, due to their ability to combine and form double helices and their interaction with meat contents are suitable structure-forming hydrocolloids for meat products [8-10]. Lambda carrageenan does not form gels in aqueous solutions; however, ƛ-carrageenan is able to form gels [8-10]. Heat-resistance properties of inulin and carrageenan make them suitable to use as a fat replacer in heated-meat products like heated-sausage [8-11]. However, there were no previously published data in this field in Iran. Therefore, the present investigation was carried out in order to study the effects of inulin and carrageenan as a fat replacer on physicochemical, textural and sensory properties of heated-sausage.

EXPERIMENTAL

Materials And Methods. Ingredients. Long chain inulin (Sensus, Netherland) and kappa-carrageenan (Sensus, Netherland) due to their heat-resistance properties were used as fat replacers. Meat (bone-free calf and lamb) were obtained from the Meat Processing Unit of the Isfahan city, Iran; the excess of fat content of the partially thawed meat was cut and separated. The meat was sliced into 1 cm^2 pieces before use. Polyphosphates, nitrites, ascorbate, and condiments were also purchased (Sigma, UK).

TABLE 1
Formulation of sausages prepared with inulin and carrageenan.

Ingredients	Amounts (Kg) in 100 kg sausage in various treatments							
	T0	T1	T2	T3	T4	T5	T6	T7
Meat	52.91	52.91	52.91	52.91	52.91	52.91	52.91	52.91
Fat	19.47	16.55	16.55	13.63	16.55	13.63	16.55	13.63
Ice	20.37	20.37	20.37	20.37	20.37	20.37	20.37	20.37
Inulin	0	0	2.92	5.84	1.46	2.92	0	0
Carrageenan	0	0	0	0	1.46	2.92	2.92	5.84
Starch	4.39	4.39	4.39	4.39	4.39	4.39	4.39	4.39
Salt	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85
Polyphosphates	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nitrates	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Sodium ascorbate	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Sausage condiment	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

Treatments. Treatments were prepared based on the method described previously by Méndez-Zamora et al. (2015) [12] with some modifications. Table 1 represents all treatments of sausage prepared in this study. Eight treatments including T0 (control group), T1 (low fat group), T2 (2.92% inulin), T3 (5.84% inulin), T4 (1.46% inulin and 1.46% carrageenan), T5 (2.92% inulin and 2.92% carrageenan), T6 (5.84% carrageenan) and T7 (2.92% carrageenan) were prepared in this investigation.

Sausage preparation. Ingredients and raw materials were added per kg of product (Table 1). Meat samples partially thawed were chopped using a cutter (Hobart Corporation, USA) for 3 min, and nitrites, ascorbate, and 1/3 of ice were added slowly. Then, polyphosphates and the remaining 1/3 of ice were incorporated, and the milling continued for 2 minutes. In the next stage, the sausage condiment was added, and the process of emulsification continued for 2 more minutes, keeping the temperature below 11 °C. The partially thawed fat was added and milled for 2 min. The starch was then added along with the rest of the ice, and the milling continued for 3 min. Once the meat dough was prepared, it was stuffed into 3 cm diameter cellulose casings using a Torrey mill (M-22 R1; N.L., México) adapted with a mouthpiece, and the sausages were manually tied with a thread every 15 cm. Subsequently, the sausages were cooked in 80 °C for 65 min. Sausages were then cooled in an ice bath (4 °C for 20 min), drained for 10 min, and refrigerated at 4 °C in polyethylene bags until analysis. Inulin and κ-carrageenan powders were added in the third step after the sausage condiment was added.

Moisture content. The moisture content was determined by weighting 5 g of the samples and drying in an oven (SW-90D, Sang Woo Scientific Co., Bucheon, Korea) at 105 °C for 24 h until reaching a constant weight as mentioned in the method of AOAC [13].

Fat content. Fat content was measured by the Soxhlet method with a solvent extraction system (SOXTEC Avanti 2050 Auto System, Foss Tecator AB, Hoganas, Sweden) based on the method of AOAC [14](14).

Protein content. Total protein content was determined according to Kjeldahl method with an automatic Kjeldahl nitrogen analyzer (Kjeltec 2300 Analyzer Unit, Foss Analytical AB, Hoganas, Sweden), which is used to determine the amount of nitrogen (%) and to calculate the ratio of protein by multiplying the amount of nitrogen to the constant factor (6.25) as mentioned in the method of AOAC [15].

Ash content. Five gram of each sample was put inside a muffle furnace at 550°C as mentioned in the method of AOAC [16].

Color analysis. Color was measured directly in the external parts of fried sausages using a HunterLab colorimeter (Brookfield, USA) and L*, a* and b* parameters were analyzed. Device was calibrated before measurements. These were performed in triplicate in sections of 2.5 cm long and 3 cm diameter.

Sensory analysis. Sensory evaluation (color, hardness, odor, taste, appearance and overall acceptability) was carried out for all the inoculated and control sausage samples using 10 trained panelists. For each sample, a score sheet from 1-9; 1 represents very dislike while 9 is very like were used. Sensory evaluation was done on fried sausage samples.

Statistical analysis. All tests were done 3 times. SPSS software (ver.18.0) was used to statistical analysis. The obtained data were analyzed by one-way (ANOVA), and significant differences ($p \leq 0.05$) among the means were compared using the Duncan' s test.

TABLE 2
Physicochemical properties of eight treatments of sausage.

Treatments	Physicochemical properties			
	Moisture	Fat	Protein	Ash
T0	57.62±2.27b	17.44±1.33a	10.39±0.46b	5.47±0.19a
T1	61.71±4.36a	8.83±0.48b	10.32±0.71b	5.40±0.37a
T2	59.18±3.69a	7.27±0.54b	11.38±0.84a	5.58±0.40a
T3	60.76±5.41a	6.21±0.028b	12.04±0.93a	5.71±0.24a
T4	59.25±5.03a	7.91±0.63b	11.06±1.03a	5.53±0.35a
T5	62.71±4.17a	6.33±0.47b	11.53±0.88a	5.67±0.39a
T6	58.64±4.36b	7.42±0.26b	11.35±0.90a	5.52±0.56a
T7	60.33±3.84a	6.37±0.19b	12.0±1.13a	5.63±0.67a

*Dissimilar letters in each column showed a significant difference in the level of 5% error.

TABLE 3
Color properties of eight treatments of sausage.

Treatments	Physicochemical properties		
	L*	a*	b*
T0	64.68±4.32a*	9.11±0.77c	11.36±0.92b
T1	63.08±5.14a	9.98±0.54a	11.35±0.87b
T2	62.61±4.49a	9.86±0.80a	11.38±1.00b
T3	57.76±4.34b	9.85±0.62a	11.40±0.66b
T4	62.05±3.68a	9.64±0.41b	11.42±1.05b
T5	61.88±5.27a	9.63±0.71b	11.53±0.94a
T6	60.31±5.71a	9.84±0.61a	11.55±1.01a
T7	55.22±3.20c	9.82±0.27a	11.60±0.99a

*Dissimilar letters in each column showed a significant difference in the level of 5% error.

TABLE 4
Sensory properties of eight treatments of sausage.

Treatments	Physicochemical properties					
	Color	Appearance	Odor	Hardness	Taste	overall acceptability
T0	5.40±5.11b*	5.41±5.33a	5.30±4.41a	5.45±3.14a	5.33±4.15a	5.46±4.85a
T1	5.52±4.32b	5.42±4.72a	4.73±4.62c	5.30±5.07b	5.10±5.20a	5.00±5.11b
T2	5.69±3.68a	5.40±4.61a	5.13±3.98b	5.39±4.44b	5.21±4.46a	5.33±4.23b
T3	5.30±4.21b	5.43±3.28a	5.24±4.06a	5.52±4.10a	5.30±3.21a	5.42±3.17b
T4	5.36±4.27b	5.41±3.22a	5.14±4.10b	5.34±4.07b	5.25±4.52b	5.35±3.82b
T5	5.70±3.36a	5.44±4.35a	5.30±3.11a	5.56±4.28a	5.39±2.71a	5.51±3.93a
T6	5.67±5.19a	5.42±5.61a	5.11±4.06b	5.41±5.11a	5.17±4.29a	5.35±4.10b
T7	5.29±4.25c	5.40±4.28a	5.20±4.18a	5.49±4.92a	5.22±3.13b	5.45±3.98a

*Dissimilar letters in each column showed a significant difference in the level of 5% error

RESULTS AND DISCUSSION

Physicochemical properties of sausage treatments. Table 2 represents the physicochemical properties of all sausage treatments. Results showed that the percent of moisture, fat, protein and ash had considerable changes with reduce in the levels of fat. We found that fat reduction caused enhancement in the percent of moisture, while caused decrease in the levels of protein, fat and ash content of sausage. In the other hand, increase in the levels of inulin and carrageenan caused increase in the percent of moisture, protein and ash and decrease in the percent of fat ($P< 0.05$). The highest percent of moisture, fat, protein and ash was found in the T5, T0, T3 and finally T3 treatments. The lowest percent of moisture, fat, protein and ash was found in the T0, T3, T1 and finally T1 treatments.

Color properties of sausage samples. Table 3 represents the color properties of various treatments of sausage samples. We found that reduction of fat from the formulation of sausage samples caused decrease in the lightness (L*) and also b* parameter, while increase in the redness (a*). Results showed that increase in the levels of inulin and carrageenan caused decrease in the levels of L* and a*, while caused increase in the levels of b* parameter ($P< 0.05$).

Sensory properties of prepared sausage samples. Table 4 represent the sensory properties of prepared sausage samples. We found that increase in the levels of inulin and carrageenan caused increase in the mean scores of judges to all parameters excluding appearance which had no significant changes. The mean scores for the odor parameter in the control group was entirely higher than others. The highest scores to the color, appearance, odor, hardness, taste and overall acceptability was for T5 treatment of sausage ($P< 0.05$).

Improve in the physicochemical properties of heated-sausage is the first finding of our study due to the replacement of fat in the formulation with

inulin and carrageenan. Fat, moisture, protein and ash are the most important characters of the food staffs. It is because of they have considerable effects on the taste, odor, texture, color and also acceptability of food products. The level of protein especially in sausage is considered to be an indicator for its nutritional value. Presence of fats helps to better frying of food products and also give it better taste. However, high presence of fats and especially saturated fats in the food products has harmful effects on the human health. High levels of moisture increase the risk of spoilage and also makes bad changes on the texture of products.

We found that reduce in the levels of fat in formulation of sausage cause increase in the percent of moisture. This finding is maybe due to the effect of fat on the retention of moisture in the sausage samples. By reducing the amount of fat, lesser amount of moisture in its absorbed shape remains in the sample and thus the moisture will increase. Decrease in the levels of fat caused decrease in the levels of protein in sausage but its change wasn't significant. There was no logical reason for this finding but it may be due to the interactions of the fat and protein in the sausage formulation. Fats have no significant effects on the levels of ash of the food products. Therefore, by reducing the amount of fat in the sausage formulation, the levels of ash will not change significantly. We also found that inulin and carrageenan caused increase in the levels of moisture. It is because of inulin and carrageenan absorb the moisture of environment and caused to increase in the levels of moisture in sausage formulation. However, this increase in the levels of moisture is not significantly high and cannot cause bacterial spoilage of sausage. In the other hand, this increase is not related to the increase in the levels of activated water (AW) which is available for bacteria. Šojić et al. (2011) [17] showed that the percent of moisture in the control sample was 57.55% and the percent of moisture in samples treated with 5% inulin was 63.67% which was similar to our findings. Huang et al. (2011) [18] showed that increase in the levels of inulin caused decrease in the percent of moisture which was dissimilar to our findings. It is may be due to the different formulation of sausage of their study with us and also type and method of using of inulin. Similar reports were found for the effects of carrageenan [8-10].

Increase in the levels of inulin and carrageenan caused decrease in the percent of fat in sausage. It is because of decrease in the amount of fat in formulation of sausage and also its replacement with inulin and carrageenan. Decrease in the levels of fat in sausage and also decrease in the amount of released energy from the fat burning in body make this kind of sausage as dietary product. Menegas et al. (2013) [19] reported that adding of inulin caused decrease in the levels of fat (24.4%) compared to the control (45.4%) and also the control group with 50% of fat (28.2%). Similar findings were reported by Méndez-Zamdra et al. (2015) [12], Šojić et al. (2011) [17] and Huang et al. (2011) [18]. Totosaus et al. (2009) [20] showed that replacement of fat in the formulation of sausage with κ-carrageenan caused significant reduce in the levels of fat and sodium chloride which was similar to our results.

We also found that inulin and carrageenan substitution caused increase in the percent of protein in sausage samples. The reason for this finding is may be due to the effects of fat reduction on the protein in sausage formulation. Fat reduction in the sausage emulsion caused aggregation of the hydrophilic proteins which may cause increase in the levels of protein in sausage samples. Savic (1985) [21] reported that the samples of chicken sausage which were produced using 1%, 2% and 3% inulin had the higher levels of protein compare to the control group. They showed that sausage samples with 3% inulin had the highest percent of protein which was similar to our results. Mendoza et al. (2001) [22] reported that the percent of protein in control group and also treatments of 7.5%, 12%, 12.50% and 14% inulin were 24%, 33.50%, 34.10%, 27.30% and 27.60%, respectively which showed increase in the levels of protein up to the 12% concentration of inulin in sausage formulation.

Increase in the substitution of inulin and carrageenan cause increase in the percent of ash in sausage which was due to the effects of inulin and carrageenan. In fact, using from long chain inulin and κ-carrageenan due to their high resistance against heating is the main factor for higher percent of ash in sausage treated with inulin and carrageenan. Similar results were reported by Méndez-Zamdra et al. (2015) [12], Šojić et al. (2011) [17], Huang et al. (2011) [18] and Totosaus et al. (2009) [20].

Color properties are another important finding of our study. Results showed that decrease in the levels of fat caused decrease in the lightness of sausage samples. This is mainly due to the application of white fat in the formulation of sausage and therefore its removal makes the appearance of sausage dark which caused reduction of L* parameter. Decrease in the levels of fat caused increase in the levels of redness (a*) and decrease in the levels of yellowness (b*). Addition of inulin and carrageenan into the formulation of sausage caused decrease in the levels of L* factor. It is because of removing of white fat from the formulation. However, this darkness and decrease of the lightness of the sausage samples were not at the levels which cause reducing of marketability of products. Decrease of the lightness in application of carrageenan was entirely higher than inulin which may be due to the lighter color of the inulin powder used in the sausage formulation. Addition of inulin and carrageenan into

the formulation of sausage caused decrease in the levels of a* factor. Besides, addition of inulin and carrageenan into the formulation of sausage caused increase in the levels of b* factor which was higher in samples treated with carrageenan. It is because of carrageenan powder has a yellow color. Šojić et al. (2011) [17] showed that the amount of L*, a* and b* factors in the control and treatment samples of sausage were 69.74, 66.21 and 12.08 and 16.18, 14.18 and 13.39, respectively which was similar to our findings. The main reason for the higher levels of redness in treatment with high amount of inulin and carrageenan and low amount of fat is due to the redness of meat used for preparation of sausage. Jiménez-Colmenero et al. (2010) [23] reported that changes in the levels of meat and fat and also addition of edible fibers are the main factors for change in the color factors. Sensory evaluation of the sausage samples confirmed some of our findings achieved from physicochemical and color-based tests. We found that the highest scores were gave to the sausage group treated with of 2.92% inulin and 2.92% carrageenan. Addition of inulin and carrageenan into the formulation of sausage caused increase in the scores gave to all parameters. Removal of fat from the formulation caused decrease in the hardness of sausage and then addition of inulin and carrageenan caused increase in the levels of hardness. Findings of previous studies [12, 17, 18, 20] showed that gums had the highest effects on the texture and color of low fat sausages. They showed that in the high concentration of inulin and carrageenan scores become increased even higher than the control group which was considerable.

CONCLUSION

In conclusion, increase of inulin and carrageenan at 2.92% replacement had the highest physicochemical, color and sensory results. This formulation can be a good approach for Iranian factories to producing weight loss heated sausage. Better taste, texture, color and lower price of sausage are another factors which can support the production of this types of sausage.

ACKNOWLEDGEMENTS

This research was supported by the Islamic Azad University, Yazd Branch, Yazd, Iran. Authors would like to thank from the staffs of the Food Science and Technology Research Center of the Islamic Azad University of Shahrekord, Iran for their important technical helps.

REFERENCES

[1] Mallika, E.N., Prabhakar, K., Reddy, P. (2009) Low Fat Meat Products-An Overview. Veterinary World. 2(9), 364-366.
[2] Akesowan, A. (2008) Effect of soy protein isolate on quality of light pork sausages containing konjac flour. African Journal of Biotechnology. 7(24), 4586-4590.
[3] Andres, S., Garcıa, M., Zaritzky, N., Califano, A. (2006) Storage stability of low-fat chicken sausages. Journal of Food Engineering. 72(4), 311-319.
[4] Yılmaz, I., Şimşek, O., Işıklı, M. (2002) Fatty acid composition and quality characteristics of low-fat cooked sausages made with beef and chicken meat, tomato juice and sunflower oil. Meat Science. 62(2), 253-258.
[5] Selgas, M., Cáceres, E., García, M. (2005) Long-chain soluble dietary fibre as functional ingredient in cooked meat sausages. Revista de Agroquimica y Tecnologia de Alimentos. 11(1), 41-47.
[6] Coussement, P., Franck, A. (2001) Handbook of dietary fiber, Marcel Dekker Inc, New York.
[7] Janvary, L. (2008) Replace fat in meat with inulin. Food Beverage Asia. 15-17
[8] Trius, A., Sebranek, J., Rust, R., Carr, J. (1994) Low-Fat Bologna and Beaker Sausage: Effects of Carrageenans and Chloride Salts. Journal of Food Science. 59(5), 941-945.
[9] Cierach, M., Modzelewska-Kapituła, M., Szaciło, K. (2009) The influence of carrageenan on the properties of low-fat frankfurters. Meat Science. 82(3), 295-299.
[10] Ayadi, M., Kechaou, A., Makni, I., Attia, H. (2009) Influence of carrageenan addition on turkey meat sausages properties. Journal of Food Engineering. 93(3), 278-283.
[11] Mensink, M.A., Frijlink, H.W., van der Voort, Maarschalk, K., Hinrichs, W.L. (2015) Inulin, a flexible oligosaccharide I: Review of its physicochemical characteristics. Carbohydrate polymer. 130, 405-419.
[12] Méndez-Zamora, G., García-Macías, J.A., Santellano-Estrada, E., Chávez-Martínez, A., Durán-Meléndez, L.A., Silva-Vázquez, R., Quintero-Ramos, A. (2015) Fat reduction in the formulation of frankfurter sausages using inulin and pectin. Food Science and Technology. 35(1), 25-31.
[13] AOAC. (2006a) Official Methods of Analysis of AOAC International, 18 ed., Maryland.
[14] AOAC. (2006b) Official Methods of Analysis of AOAC International, 18 ed., Maryland.
[15] AOAC. (2006c) Official Methods of Analysis of AOAC International, 18 ed., Maryland.
[16] AOAC. (2006d) Official Methods of Analysis of AOAC International, 18 ed., Maryland.

[17] Šojić, B.V., Petrović, L.S., Pešović, B.M., Tomović, V.M., Jokanović, M.R., Džinić, N.R., Salitrežić, P.P. (2011) The influence of inulin addition on the physico-chemical and sensory characteristics of reduced-fat cooked sausages. Acta Periodental Technologu. (42), 157-164.
[18] Huang, S., Tsai, Y., Chen, C. (2011) Effects of wheat fiber, oat fiber, and inulin on sensory and physico-chemical properties of chinese-style sausages. Asian Australial Journal of Animal. 24(6), 875-880.
[19] Menegas, L.Z., Pimentel, T.C., Garcia, S., Prudencio, S.H. (2013) Dry-fermented chicken sausage produced with inulin and corn oil: Physicochemical, microbiological, and textural characteristics and acceptability during storage. Meat Science. 93(3), 501-506.
[20] Totosaus, A., Alfaro-Rodriguez, R., Perez-Chabela, M. (2004) Fat and sodium chloride reduction in sausages using κ-carrageenan and other salts. International Journal of Food Science and Nutrition. 55(5), 371-380.
[21] Savic, I. (1985) Small-scale sausage production, FAO.
[22] Mendoza, E., Garcıa, M., Casas, C., Selgas, M. (2001) Inulin as fat substitute in low fat, dry fermented sausages. Meat Science. 57(4), 387-393.
[23] Jiménez-Colmenero, F., Herrero, A., Pintado, T., Solas, M., Ruiz-Capillas, C. (2010) Influence of emulsified olive oil stabilizing system used for pork backfat replacement in frankfurters. Food Research International. 43(8), 2068-2076.

Received: **19.05.2018**
Accepted: **20.09.2018**

CORRESPONDING AUTHOR

Seyed Ali Yasini Ardakani
Department of Food Science and Technology,
College of Agriculture,
Islamic Azad University,
Yazd Branch, Yazd Iran.

e-mail: a.yasini@gmail.com

EFFECTS OF HOT AIR AND MICROWAVE DRYING TECHNIQUES ON DRYING CHARACTERISTICS AND SOME QUALITY PARAMETERS OF *TROPAEOLUM MAJUS* L.

Fusun Hasturk-Sahin[1,*], Funda Eryilmaz-Acikgoz[2], Murat Deveci[3], Sekure Sebnem Ellialtioglu[4], Turkan Aktas[5]

[1]Tekirdag Namik Kemal University, Vocational School of Hayrabolu, Department of Agricultural Machinery, Tekirdag, Turkey
[2]Tekirdag Namik Kemal University,Vocational School of Technical Sciences, Department of Plant and Animal Production, Tekirdag, Turkey
[3]Tekirdag Namik Kemal University, Faculty of Agriculture, Department of Horticulture,Tekirdag, Turkey
[4]Ankara University, Faculty of Agriculture, Department of Horticulture,Ankara, Turkey
[5]Tekirdag Namik Kemal University, Faculty of Agriculture, Department of Biosystem Engineering, Tekirdag, Turkey

ABSTRACT

In the current work, it was purposed to dry the edible flowers of *Tropaeolum majus* L. plant by using different methods. For this purpose, the plants were grown in a climate chamber with a temperature of 22/16°C (day/night), 70% relative humidity, 14/10 (daylight/night) hours photoperiodic regime with light intensity of 400 µmol $m^{-2}s^{-1}$. Then the flowers were dried by convective hot air drying and microwave drying methods. In account of hot air drying, four different drying temperatures were applied, namely 30°C, 40°C, 50°C and 60°C. Four dissimilar power levels, namely 90 W, 180 W, 360 W and 600 W, were applied for the microwave drying. Some analyzes such as the kinetics of color changes, water activity were carried out to evaluate the quality characteristics of the fresh and dried flowers. Hot air drying took 59, 25.5, 9 and 5 hours for 30°C, 40°C, 50°C and 60°C drying temperatures, respectively. Microwave drying took 72.5, 22.5, 13 and 7 minutes for 90W, 180W, 360W and 600W power levels, respectively. All drying applications altered all three color parameters (L*, a*, b*) and caused decrease in water activity values.

KEYWORDS:
Tropaeolum majus L., convective hot air drying, microwave drying, color, water activity

PRACTICAL APPLICATIONS

Tropaeolum majus L. is one of the edible flowers and it is consumed by being processed like freezing and frying as well as fresh consumption. This flower is highly perishable plant due to its high moisture content similar to vegetables and fruits. For this reason, it can be dried using natural drying methods or modern drying systems to extend its shelf life. In this way, this plant's leaves and flowers can be consumed by drying as well as fresh consumption. Aim of this research is to compare preservation processes, hot air and microwave drying, with regard to drying kinetics, color properties and water activity changes of *Tropaeolum majus* L. in order to obtain high value dried product.

INTRODUCTION

Drying is an important food conservation method. Today, many drying methods are applied especially fruits and vegetables for drying purpose. The flowers, leaves and stems of plants are used as fresh in salads. Edible flowers are used in China, India, Middle East, North America and Europe for centuries to start with the Romans for taste and flavor.

The flower is the most important part of the plant and contains large amounts of natural antioxidants such as phenolic acids, flavonoids, anthocyanins [1, 2].

Edible flowers have gained popularity in the last few years in culinary magazines, cookbooks and visual media. In many parts of the world, flowers are traditionally consumed. Consumers buy packaged flowers for use in garnishes, salads, drinks, soups, meadows, packed ice cubes, cocktails [3, 4, 5, 6]. Edible flowers are also consumed by being processed like freezing and frying as well as fresh consumption [7]. In many countries of the world, the consumption of edible flowers is due to the nutritional value as well as some medicinal properties [8, 9, 10].

Tropaeolum majus L. is also one of the edible flowers and belongs to the family *Tropaeolaceae*. This plant is single year, very fast growing, 30 cm to 90 cm in height can climb, a climbing feature. This plant, which can consume leaves and flowers, is used to decorate the gardens in many regions of our country. An unknown, exotic plant that is unaccounted for in terms of the consumption of flowers and leaves [11]. As with vegetables, it is a product with a quick deterioration feature. For this reason, in addition to fresh consumption, natural drying methods or drying systems can be used to enhance

the shelf-life and ensure seasonal consumption.

Dried vegetables in recent years have become more significant because the food industry directly consume these in place of fresh foods [12]. Longer shelf life makes dried fruits and vegetables more popular, increase product variety and reduced product volume. This can lead to improvements in product quality in food processing applications [13].

In the current work, it was purposed to detect the quality characteristics of dry product obtained as a result of drying of edible flowers of *Tropaeolum majus* L. flower plant grown by seed planting in the climate chamber provided with ecological controls by different drying methods.

MATERIAL AND METHODS

Obtaining of Edible Flowers of *Tropaeolum Majus* L. Plant: Plant seeds were planted in a multi-chambered box filled with peat, in a climate chamber where the temperature can be arranged between +40°C and -20°C. All experiments were carried out in this chamber with a temperature of 22/16°C (day/night), 70% relative humidity, 14/10 (daylight/night) hours photoperiodic regime, light intensity of 400 µmol $m^{-2}s^{-1}$.

After planting, plant growth was monitored. The first flower harvest was begun 50-55 days after planting and the harvest was carried out continuously.

The harvested flowers were dried with convective hot air drying and microwave drying methods. For each drying application, the drying kinetics of the plants were examined, and the changes of color properties and water activities in fresh and dried samples were determined.

Drying Methods. Convective hot air drying. For hot air drying applications, convective hot air dryer was used. Dimensions of this drying cabinet are 50 cm x 100 cm and 2 mm thickness galvanized metal sheet was used as cabinet material.Two electrical heaters were used to supply hot drying air (Figure 1). Electrical heaters were positioned inside air heating canal. The air heating canal was constructed from galvanized sheets in the form of a cylinder that is 50 cm in length. Heaters can be activated individually by two level control switch (Legrand). When the switch is in zero stage, one heater works and both heaters can also be activated when the switch is in first stage. A centrifugal ventilating fan (Demsan-DYK 18/150) was used to speed up drying air in dryer. This fan can be worked at different speeds by 5-stage speed switch (SCNR5 model). An analogue heat control unit with digital indicator (ARM 396 model) was used to fix up drying air temperature. This unit can actuate between 0-400°C temperatures. Drying cabin and air heating cabin were isolated using 30 mm glass wool and aluminium foil to avoid heat losses. Samples were placed on cancellated tray to supply the sufficient ventilation [14]. A weighing system consists of an electronic scales and sample tray. The scales (AND brand balance) was setted outside the drying cabinet and connected to a PC. Sample tray was connected to electronic scales. Thus, samples were weighed automatically and weights were recorded to the computer periodically.

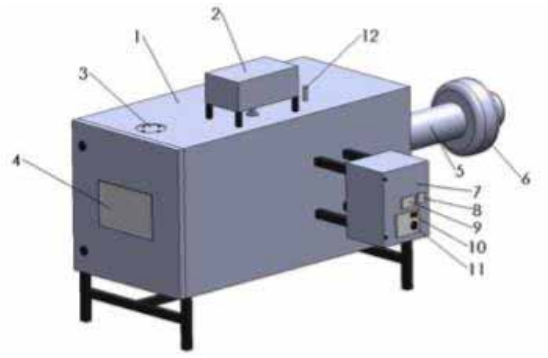

FIGURE 1
Convective hot air dryer (1: Drying chamber, 2: Scales, 3: Moist air outlet, 4: Product entry and exit door, 5: Heater, 6: Fan; 7: Control panel, 8: Heater control switch, 9: Temperature control unit, 10: Power switch, 11: Speed switch, 12: Temperature sensor) [15].

Microwave drying. Microwave drying applications were performed using a microwave oven (with Beko brand, 2450 MHz frequency, maximum 800 W power and 19 lt inner space), as seen in Fig. 2. [16]. Electronic balance (AND brand) was used to measure the weight losses during microwave drying, continuously using interface programs, such as hot air dryer.

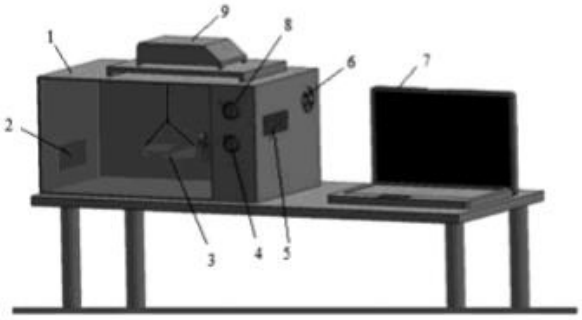

FİGURE 2
Microwave dryer (1: Microwave oven; 2: Ventilation holes; 3: Tray; 4: Timer; 5: Magnetron; 6: Fan; 7: Computer; 8: Power switch; 9: Scale) [16].

Drying experiments. Hot air and microwave drying trials were carried out at 30°C, 40°C, 50°C, 60°C drying temperatures and 90 W, 180 W, 360 W, 600 W power levels, respectively.

Determination of Quality Parameters. Determination of dry matter. Dry matter amounts were determined by oven drying method at 105 °C temperature [17, 18].

Color analysis. Color measurements of fresh and dried *Tropaeolum majus* L. flower samples were performed using Hunter-Lab tristimulus colorimeter (D25LT, Hunter Associates Laboratory, Reston, Virginia). CIE L*a*b* color parameters were measured from 10 points of every sample stack just after drying processes. In the CIE L*a* b* color system L* value represented the lightness of color (0= black, 100= white), a* represented the red color and b* represented the yellow color. Total color difference (ΔE*), Lightness difference (ΔL*), Color chroma difference (ΔC*) and Metric hue value (H*) were calculated in accordance with the equations as seen below (Anonymous, 1996). There is no color standard for dry *Tropaeolum majus* L. therefore color properties of fresh flower samples were approved as reference values [18].

$$\Delta L^* = L^*_{sample} - L^*_{standard}$$
$$\Delta a^* = a^*_{sample} - a^*_{standard}$$
$$\Delta b^* = b^*_{sample} - b^*_{standard}$$
$$\Delta E^* = \sqrt{\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2}}$$
$$C^* = \sqrt{a^{*2} + b^{*2}}$$
$$\Delta C^* = C^*_{sample} - C^*_{standard}$$
$$\Delta H^* = \sqrt{\Delta E^{*2} + \Delta L^{*2} + \Delta C^{*2}}$$
$$H = tan^{-1}\frac{b^*}{a^*}$$

When ΔL* has positive value, dried sample is brighter than before drying application. But if ΔL* has negative value, it means that dried sample is more matt than before drying application. When Δa* has positive value, sample is more red than before drying. If Δa* has negative value, sample is greener than before drying. When Δb* has positive value, dried sample is more yellow than before drying. But if Δb* has negative value, dried sample is more blue than before drying at that time. ΔH* index is a chromatic deviation model which contains whole color parameters. ΔH* value describes the color change direction. On the other hand ΔE* and ΔC* indexes, which is given for comparing with other indexes, are not a good determiner to describe color differences. For example different colors can have same chroma value [19].

Water activity measurements. Water activity values of fresh and dried *Tropaeolum majus* L. flower samples were measured using a water activity measurement device by combining Testo 650 data logger. During the measurements, sample was placed in a small chamber. Then, the water in the air is measured after it equilibrates with the sample. Reached equilibrium moisture value was directly measured by a probe which placed into the chamber [20, 18].

Statistical analysis. All statistical analyses were performed with SPSS (PASW Statistics 18).

RESULTS AND DISCUSSION

Hot air drying kinetics. Inceptive moisture content of flower samples was found to be 89,92% and moisture ingredient of dried flower samples changed between 26.28% and 58.42%, bound up with the hot air drying methods. Drying process performed using hot air dryer lasted about 59 hours for 30°C drying temperature condition. Saeed [21] searched that solar drying behaviour of roselle (*Hibiscus sabdariffa* L.). Acoording to researcher, drying air temperature was the master factor impressing the drying behaviour of Roselle since raising the temperature strikingly reduced the drying time. It was observed that drying of *Tropaeolum majus* L. flower samples, especially at 30°C drying temperature, take longer time and the final moisture content of dried samples was found very high (Fig. 3; HA: Hot Air, MW: Microwave). Such that; at the end of 10th hour at 30°C drying temperature, moisture ingredient of flower samples decreased from 89.92% to 86.35%. At the end of this period, moisture loss of samples was only 3.57%. Moisture content of samples were 84.28%, 80%, 74.17% and 67.91%, at 20th, 30th, 40th and 50th hour, respectively. Within the last 9 hours, the moisture decrease was 11.13% and the final moisture content of the samples was found to be 56.78%.

Drying time shortened with the rise of drying temperature. According to Saeed et al. [22] roselle drying time decreased as air temperature increased. Drying of the samples took place at 25.5 hours at a drying temperature of 40°C. Nevertheless, the moisture ingredient of the dried samples was detected to be quite high (58.42%) in this drying application. At the end of 10th hour at this drying application, moisture content of flower samples decreased from 89.92% to 80.76%. At the end of this period there was a 9.16% drop in sample moisture. Moisture ingredient of samples was found to be 66.39% at the 20th hour and 58.42% at the 25.5th hour. The total moisture loss was determined as 31.50% at the 25.5th hour.

In this research stalks of flower samples were also evaluated with flower part. In general, during drying applications, drying of flower stalks took longer period than its petal. This situation was determined for both 30°C and 40°C drying temperatures. It was observed that the stalk parts dried more effectively with the rise in drying temperature.

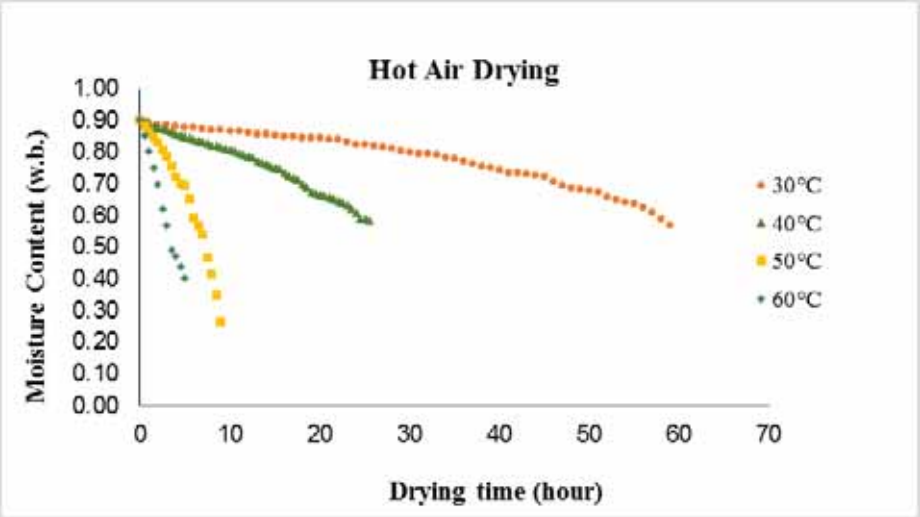

FIGURE 3
Hot air drying curves for *Tropaeolum majus* L.

Increasing the drying temperature to 50°C caused to very positive results in terms of both drying time and final moisture contents. At the end of 4th hour at 50°C drying temperature, moisture content of flower samples decreased from 89.92% to 83.03% and the moisture decrease was found as 17.52%. Moisture content of flower samples determined as 59.44% at 6th hour. At the end of this period, moisture loss of samples was 30.48%. The loss at the end of the 8th hour was 48.64% and the sample moisture content at this point was 41.28%. When the same durations were considered in the period of drying, these decreases are considerably higher than in 30°C and 40°C applications. At the end of 9 hours, the final moisture ingredient of flower samples was found to be 26.28% at 50°C drying temperature application. These changes were shown in Figure 3. Balladin and Headley [23], researched the solar drying of rose petals. The rose petals were dried in 2 days at about 30°C and reached equilibrium moisture content after 16 h using the solar dryer. The initial moisture ingredient and final moisture content were determined as 65.7% and 25.2%, respectively. Baydar et al. [24], researched that the effects of cold storage and drying on essential oil ingredient and composition in oil-bearing rose flowers. For these purpose, researchers applied three drying methods for rose flowers namely, drying under the room conditions (24±3°C), shadow drying and drying on the wire shelves for 7 days. The amount of moisture content of dry flowers and dry petal leaves was determined as 15% while moisture content value of the fresh flowers drying under the room condititons was determined as 10%.

At the end of first hour at 60°C drying temperature, moisture content of flower samples decreased from 89.92% to 80.38%. At the end of this period, moisture loss of samples was found as 9.54%. Same moisture loss amount occured in 10th hour at 40°C drying temperature application. As it can be seen from these loss rates, increasing the drying temperature effectively increased drying rate of flower samples. Drying of the flower samples was completed within 5 hours (Figure 3). Obtained drying time results were found parallel to the findings of Deena et al. [25]. They researched that hot air drying of chrysanthemum flowers at different drying temperatures i.e. 40, 50, 60 and 70°C. In this research, chrysanthemum flowers were dried in 6 hours at 50°C. The moisture ingredient of flower samples was found to be 40% after 5 hours for 60°C drying application.

Microwave drying kinetics. Increasing of power levels decreased the drying time for microwave drying of flower samples (Figure 4). Among the microwave dried flower samples, highest moisture content was found for the sample that was dried at 90W power level. In this drying application, moisture content of flower samples was determined as 84.63% at 20th minute. At the end of this period, moisture loss of samples was 5.29%. The moisture loss values at the end of 40th and 60th minute were calculated as 12.27% and 20.76%, respectively. Microwave drying at 90 W power level took 72.5 minute and moisture content of flower samples was determined as 55.61%. At the end of this application, total moisture loss of samples was 34.31%. For 90 W applications in microwave drying, the final moisture content of samples was determined to be rather higher due to the low power level.

It was determined that increasing power levels in microwave drying significantly affected drying time and the final moisture ingredient of flower samples. At the end of 10th minute, moisture loss of samples was found as 17.83% for 180W power level application. 180W power level applications took 22.5 minutes and moisture content of flower samples was determined as 32.53%. Total moisture loss of sample was found as 57.39% at the end of

drying period. This loss is quite remarkable compared to 90W power level application.

Final moisture content of flower samples determined as %30.20 at the end of 13 minutes drying time for 360W power level application during microwave drying. Raol Jaydipsinh et al. [26] dried rose flowers by microwave drying method and found 13 minutes drying period in parallel with our research result. When the 360W power application was examined, it was observed that flower samples reached to 70.36% moisture content with 19.56% moisture loss rate at the end of 5 minutes and to 43.16% moisture content with 46.73% moisture loss at the end of 10 minutes. When the flower samples reached to 30.20% final moisture content, the total moisture loss rate was determined as 59.72%.

Final moisture content of flower samples was determined as 24.24% at the end of 7 minutes drying time for 600W power level application in microwave drying. This final moisture content value was regarded as the lowest moisture content achieved in all drying applications, including with hot air drying applications. Finally this period, total moisture loss of flower samples was found as 65.68%. The targeted final moisture content was approached further with 600W power application.

According to Trinklein [27], microwave drying gets a few minutes and ensures dried flowers which look fresher and more colorful than those attained by other drying methods. Drying time changed from about 3 minutes for intense flowers with numerous petals to just about 1 minute for smaller and thinner-petaled flowers.

Changing of dry matter. According to statistical analysis results, differences between dry matter contents in dried flower samples were found significant for all drying methods ($P<0.001$). Changes of dry matter amounts of fresh and dried flower samples were shown in Figure 5. Dry matter value of fresh flower was determined as 10.08%. It was determined that maximum and minimum dry matter amount were found in the samples that were dried microwave method with 600W power level application (75.76%) and hot air drying that was performed at 40ºC temperature (41.58%), respectively. Moisture contents of these dried products were determined as 24.24% and 58.42%, respectively. These moisture content values were obtained after 7 minutes and 25.5 hours, respectively. Chen et al. [28] investigated that the effects of different freezing times and vacuum drying temperatures on color, moisture ingredient and stem and petal strengths of roses and carnations. Researchers were detected similar moisture content values in their study. Hahn et al. [29], investigated that optimization of roselle (*hibiscus sabdariffa*) drying time and drying quality. Researchers analyzed three different systems for roselle calyx drying using the same polyethylene plastic tunnel. They determined the final moisture content of roselle samples as 12%. According to Dilta et al. [30], moisture content of the flowers after drying influenced flower form. The lower moisture content provided rigidity and results in uniform cell contraction in the flowers while the higher moisture content in dried flowers cause weak flowers. Singh et al. [31] investigated that dehydration technique of zinnia flower (*zinnia linearis*). Researchers reported that phenomena of dehydration related to petal shape, color and longevity, revealed 8 to 11.5% moisture content as an optimum level of dehydration for maintaining six months longevity and good flower shape. These results, which were presented by researchers, were not related with dried edible flowers, they included only dried flowers. Crumbling of flowers also increased with the decrease of the final moisture content of flowers. Final moisture content of the *Tropaeolum majus* L. Flower, that is an edible flower, was found as slightly higher than the recommended level for other dried flowers, is considered acceptable for this research with considering of the higher crumbling situation.

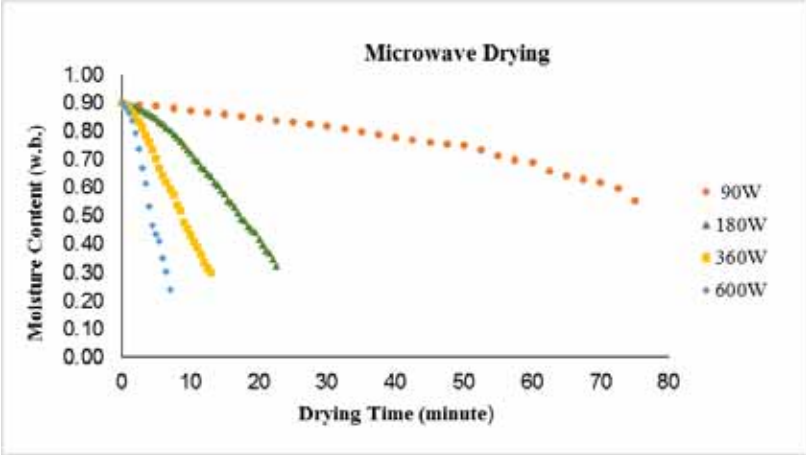

FIGURE 4
Microwave drying curves of *Tropaeolum majus* L.

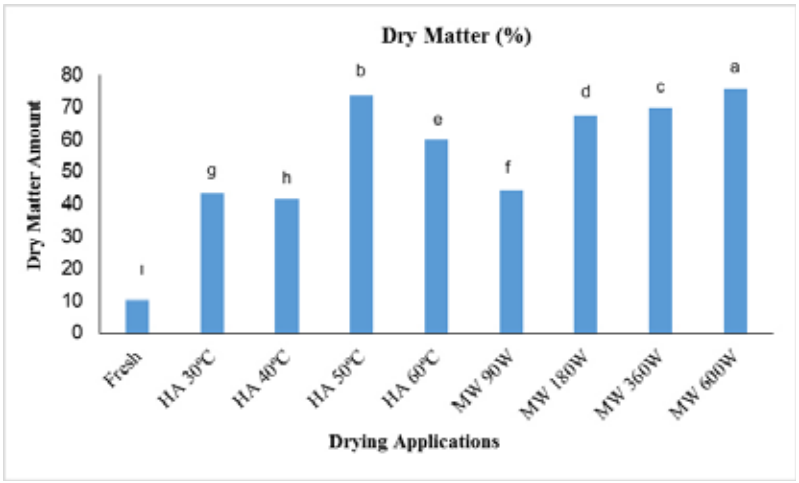

FIGURE 5
Dry matter amounts of dried *Tropaeolum majus* L.

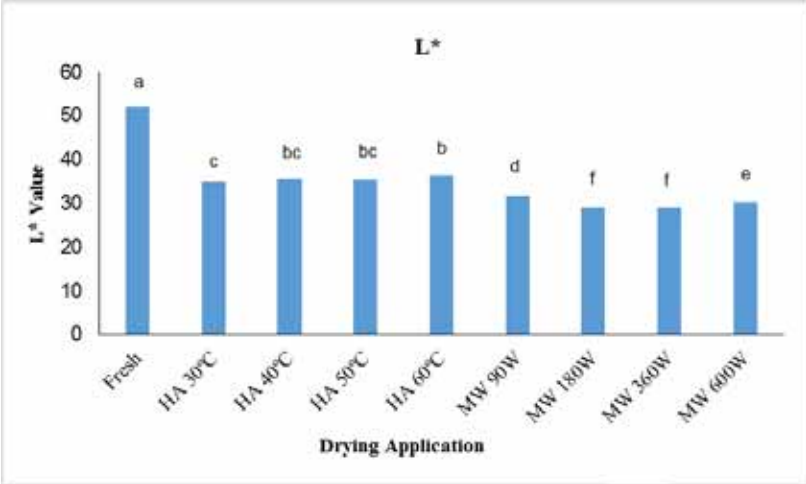

FIGURE 6
Changes of L* values of dried *Tropaeolum majus* L

Changing of color parameters. Color is a very imponant feature of foods and is subject to important changes during processing [32]. It is a sing of the innate good qualities of a food and association of color with relevance of food is global [33]. Color is the one of the most important aesthetic characteristics for flowers and identifying process parameters thar incur the least amount of color change is important [28]. Hunter color parameters have formerly been indicated to be estimable in defining visual color deterioration and ensuring useful information for quality control in fruits and vegetables [34].

L* value of samples that were dried using hot air drying 40 and 50ºC temperatures and microwave drying 180 and 360W power levels were found in the same group according to statistically evaluation. So, the differences between these groups were found not significant (P>0.001). Generally, differences between L* values of other samples were found statistically significant (P<0.001). L* values of dried flower samples decreased compared to that value of fresh sample (Figure 6). But, these decreases in L* value did not visually affect the brightness value of flower. It was determined that minimum and maximum L* values were found in the samples that were dried microwave drying at 360W power level (28.94) and hot air drying that was performed at 60ºC temperature (36.27), respectively. L* value of fresh flower sample was determined as 51.99. L* values of all hot air dried flower samples were higher than the those of microwave dried ones.

The positive a* value of all dried samples was an expected result because orange color of the selected variety of flower for drying applications. a* value of fresh flower sample was determined as 27.38. The a * values of all dried flowers were found lower than that of the fresh ones (Figure 7). This result shows that the redness value of dried flowers decreased. Generally, the difference between a* values of flower samples was found statistically significant (P<0.001). In addition to this, some samples were found in the same group (P>0.001). It was determined that maximum a* value was found in samples that were dried using

microwave drying at 180W power level. These samples were followed by hot air dried samples at 60ºC drying temperature and microwave dried samples at 90W power level. The a * values of these samples were determined as 10.70, 10.67 and 10.43, respectively and statistically they are in the same group. The a* values of hot air dried samples at 40°C and microwave dried samples at 600 W were found almost the same. a* values of these samples were determined as 9.48 and 9.47 and they were found in the same group statistically. It was determined that minimum a* value was found in samples that were dried using hot air drying at 50°C. a* value of these samples was measured as 7.02.

As seen in Figure 8, b* values decreased after all drying applications. This result shows that the yellow color tone decreased after all drying processes of flower samples. b* value of fresh flower sample was determined as 50.69. b* value of all hot air dried flower samples was found higher than microwave dried ones. As per consequences of hot air drying applications, b* values of dried flower samples increased with the rising of drying temperature. So, the shortening of the drying periods positively affected the b* values of dried samples. Generally, the differences between a* values of flower samples were found statistically significant (P<0.001). In addition to this, some examples were found in the same group (P>0.001). b* value of fresh flower was determined as 50.69. It was determined that minimum and maximum b* values were found for the hot air dried samples that were dried at 30 ºC temperature (21.76) and 60 ºC temperature (28.36), respectively. According to results of microwave drying applications, b* values of dried flower samples decreased with the rising of power levels. The b* values of microwave dried samples at 90 W and 180 W power level applications were determined almost the same. b* values of these samples determined as 20.48 and 20.56 and statistically they were found in the same group. Minimum b* value of microwave dried samples was determined as 18.40 at 600 W power level application. This value of microwave dried samples that were performed at 360 W power level applications was determined as 19.09 and it was in the same group with 600 W applications.

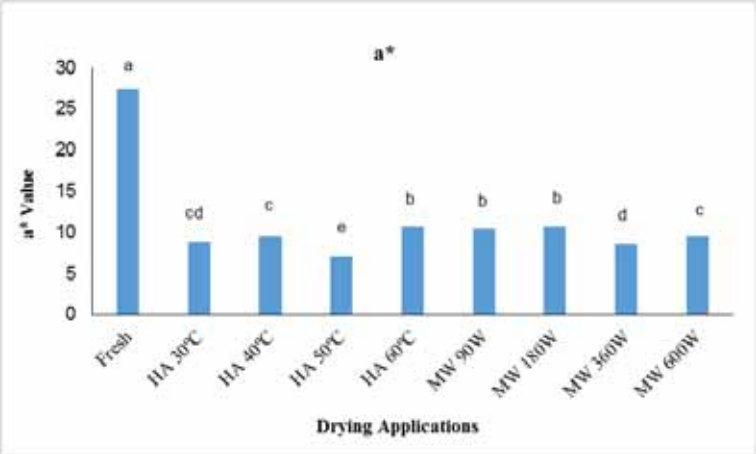

FIGURE 7
Changes of a* values of dried *Tropaeolum majus* L.

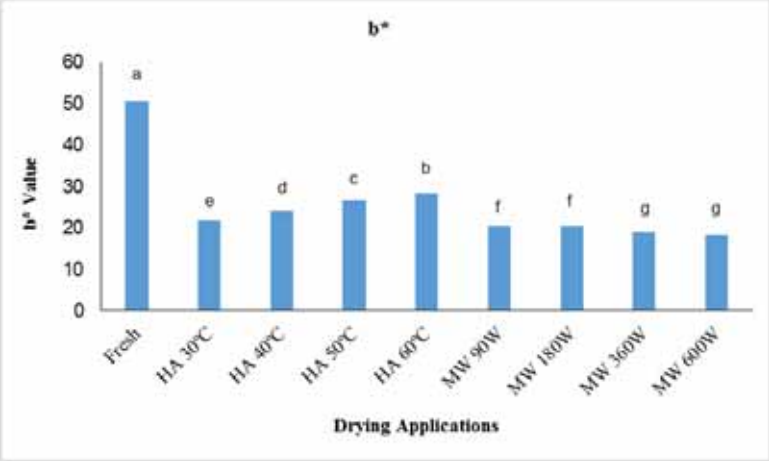

FIGURE 8
Changes of b* values of dried *Tropaeolum majus* L.

TABLE 1
Changes the color quality of dried *Tropaeolum majus* L.

Applications	ΔL*	Δa*	Δb*	C	ΔE*	ΔC*	ΔH*	H
HAD 30ºC	-17.15	-18.57	-28.93	23.48	38.42	-34.13	54.18	1.19
HAD 40ºC	-16.36	-17.90	-26.42	26.06	35.86	-31.55	50.49	1.20
HAD 50 ºC	-16.72	-20.36	-24.04	27.56	35.67	-30.05	49.54	1.31
HAD 60 ºC	-15.72	-16.71	-22.33	30.30	32.02	-27.31	44.92	1.21
MWD 90W	-20.36	-16.95	-30.21	22.98	40.18	-34.63	56.82	1.10
MWD 180W	-22.96	-16.68	-30.13	23.18	41.39	-34.43	58.53	1.09
MWD 360W	-23.05	-18.76	-31.60	20.95	43.38	-36.66	61.30	1.15
MWD 600W	-21.74	-17.91	-32.29	20.69	42.85	-36.92	60.59	1.10

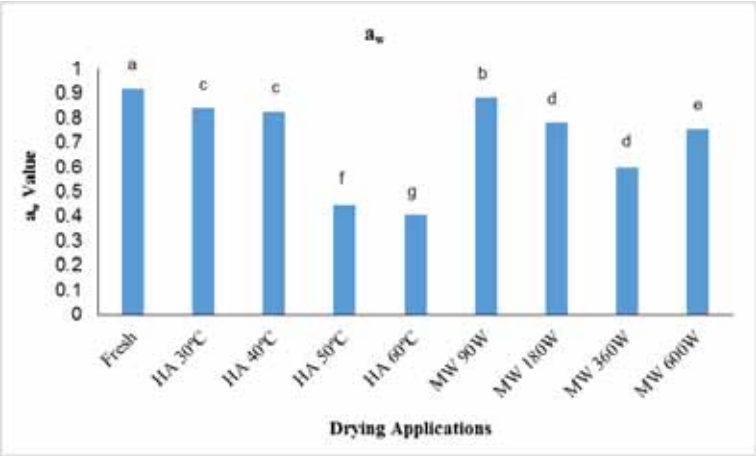

FIGURE 9
Changes of water activity of dried *Tropaeolum majus* L.

Changing of color parameters were calculated using of L*, a* and b* values of fresh and dried samples as given in Table 1. As seen in Table 1, ΔL*, Δa* and Δb* values of all samples were found negative. It means that dried samples are more opaque, more green and more blue compare to fresh sample.

The ΔE* is a single value which considers the differences between the L*, a* and b* of the sample and standard. In addition, there are two other delta values that are related to this scale, ΔC* and ΔH*. The ΔC* is the difference in chroma between the sample and standard as defined in a polar coordinate system. The ΔH* is the difference in hue angle between the sample and standard as defined in a polar coordinate system [35]. H is the metric hue angle of a color in degree. Larger ΔE* indicates greater color change from the fresh material [36]. In this case, as seen in Table 1, minimum and maximum color change occured in 60ºC hot air application and 360W microwave drying application.

Changing of water activity: Bacteria number in food that causes to important deterioration problems can not increase if water activity value of food is under 0.90. Also mold growth stops completely under water activity value of 0.65. In addition to these decreasing of water activity value stops or restricts the enzymatic changes [37].

Moisture content and water activity of a food influence texture, storage stability and its sensitivity to microbial deterioration [38]. According to statistical analyses results, the differences between the a_w values of the samples were found significant ($P<0.001$). As seen in Figure 9, a_w value decreased for all dried samples. While minimum a_w value (0.404) was found for 60ºC hot air application, maximum a_w value (0.882) was found for 90W microwave drying application.

The final moisture contents were found over 50% of three dried samples which a_w values were measured over 0.80. These samples were dried at 30ºC hot air, 40ºC hot air and 90W microwave drying application. Final moisture contents of these dried products were determined as 56.78%, 58.42% and 55.61%, respectively. Namely, these moisture contents were the highest values among all of the dried product's moisture content values. At low a_w, water can only be adsorbed at the surface places. As the a_w increases, the solvation of soluble components occurs with increasing the moisture content [39].

CONCLUSION

In all drying methods, the longest drying process took 59 hours in hot air drying performed using 30ºC temperature and the shortest drying process took 7 minutes in microwave drying performed using 600W power level application. It was determined that drying periods within normal limits for all applications. It is very important that dried edible flowers can preserve their color characteristics

of fresh condition after drying processes. In this study, dried *Tropaeolum majus* L. flowers were examined in terms of important color criteria, namely L*, a* and b*. These values decreased with all drying applications. However, it was seen that these color tone reductions did not visually affect the color properties of dried flowers. L* values of hot air dried samples was higher than those obtained by microwave drying method. The highest L * value was determined in hot air dried samples that were performed at 60ºC drying temperature. The same samples gave good results in terms of a* and b* values, compared to other samples. The positive values of a* and b* in all samples indicate that the *Tropaeolum majus* L. flower retains its own distinctive orange and yellow color tone of the selected species for drying. a_w (water activity) values of dried flower samples were determined generally lower value that is critical value to growth of bacteria.

ACKNOWLEDGEMENTS

The authors would like to thank the Namik Kemal University Scientific Research Projects Unit for its financial support to the project numbered with NKUBAP.42.GA.16.084

REFERENCES

[1] Kaur, G., Alamb, M.S., Jabbar, Z., Javed, K., Athar, M. (2006). Evaluation of antioxidant activity of cassia siamea flowers. Journal of Ethnopharmacology. 108(3), 340– 348.

[2] Youwei, Z., Jinlian, Z., Yonghong, P. (2008). A comparative study on the free radical scavenging activities of some fresh flowers in Southern China. LWT – Food Science and Technology. 41(9), 1586-1591.

[3] Barash, C.W. (1997). Edible flowers: Desserts and drinks. Colorado: Fulcrum Publishing; Golden. pp. 96.

[4] Kelley, K.M., Cameron, A.C., Biernbaumb, A.J., Poff, K.L. (2003). Effect of storage temperature on the quality of edible flowers. Postharvest Biology and Technology. 27, 341–344.

[5] Kopec, K., Balik, J. (2008). Kvalitologie zahradnickych produktu, 1st ed.; Mendel University of Agriculture and Forestry in Brno: Brno, Czech Republic, pp. 140161.

[6] Rop,O., Mlcek, J., Jurikova, T., Neuge-bauerova, J., Vabkova, J. (2012). Edible flowers a new promising source of mineral elements in human nutrition. Molecule. 17(6), 6672-6683.

[7] Belsinger, S. (1991). Flowers in the kitchen. Loveland, Colorado: Interweave Press.

[8] Vachirasup, T. (1995). Senna plant in Thailand. (1st ed.) Faculty of Pharmacy, Mahidol University, Bangkok, Thailand.

[9] Boonyaprapatsara, N. (2000). Thai traditional herbal medicine plant. Vols. 1 and 4. Bangkok, Thailand: Prachachon Publ.

[10] Mlcek, J., Rop, O. (2011). Fresh edible flowers of ornamental plants a new source of nutraceutical foods. Trends in Food Science & Technology. 22(10), 561-569.

[11] Garzón, G. A., Wrolstad, R. E. (2009). Major anthocyanins and antioxidant activity of nasturtium flowers (Tropaeolum majus). Food Chemistry, 114: 44-49.

[12] Aktas, T., Hasturk Sahin, F., Fujii, S., Yamamoto, S. (2010). Adsorption ısotherms of freeze dried vegetables. 17th International Drying Symposium (IDS 2010) Magdeburg, Germany, 3-6 October.

[13] Parakash, S., Jha, S. K., Datta, N. (2004). Performance Evaluation of Blanched Carrots Dried by Three Different Driers. Journal of Food Engineering. 62(3), 305–313.

[14] Hasturk Sahin, F., Aktas, T., Orak, H.H., Ulger, P. (2011). Influence of pretreatments and different drying methods on color parameters and lycopene content of dried tomato. Bulgarian Journal of Agricultural Science. 17 (6), 867-881.

[15] Hasturk Sahin F., Aktas, T., Altan, D.D., Eryilmaz Acikgoz, F. (2017). Effects of different drying techniques on drying characteristics and some quality attributes of sorrel (Rumex Acetosa L.). Oxidation Communications. 40(1-II), 345-358.

[16] Celen, S., Aktas, T., Karabeyoglu, S.S., Akyildiz, A. (2016). Drying behavior of prina (crude olive cake) using different type of dryers. Drying Technology. 34(7), 843-853.

[17] Cemeroglu, B. (2007). Gıda analizleri. Gıda Teknolojisi Derneği Yayınları No:34. Bizim Büro Basımevi, Ankara, 535s. (In Turkish).

[18] Aktas, T., Ulger, P., Daglıoglu, F., Hasturk. F. (2008). Effect of storage time on quality of plum osmotically pretreated with trehalose and sucrose solutions before drying. 10th International Congress on Mechanization and Energy in Agriculture, Proceedings, Antalya, 904-909.

[19] Soysal, Y., Oztekin, S., Isikber, A.A., Duman, A.D., Dayisoylu, K.S. (2005). Kurutulmuş kırmızıbiberde rengin bir kalite parametresi olarak önemi. III. Tarımsal Ürünleri Kurutma Tekniği Çalıştayı, 2-4 Mayıs, Antalya, S. 74-81. (In Turkish).

[20] Aktas, T., Polat, R. (2007). Changes in the drying characteristics and water activity values of selected pistachio cultivars during hot air drying. Journal of Food Process Engineering. 30(5), 607-624.

[21] Saeed, I.E. (2010). Solar drying of roselle (Hibiscus sabdariffa L.) Part I: Mathematical modelling, drying experiments, effects of the drying conditions. Agricultural Engineering International: CIGR Journal, 12(3-4), 115-123.
[22] Saeed, I.E., Sopian, K., Abidin, Z. Z., (2006). Drying kinetics of roselle (Hibiscus sabdariffa L.): Dried in constant temperature and humidity chamber. In Proceedings SPS 2006, 143148. Permata, Bangi, Malaysia. August 2930. S
[23] Balladin, D.A., Headley, O. (1999). Solar drying of rose (Rosa sp.) petals. Renewable Enegy. 18, 249-255.
[24] Baydar, H., Kazaz, S., Erbaş, S., Örücü, Ö.K. (2008). Soğukta Muhafaza ve Kurutmanın Yağ Gülü Çiçeklerinin Uçucu Yağ İçerigi ve Bileşimine Etkileri. Süleyman Demirel Üniversitesi Ziraat Fakültesi Dergisi. 3(1), 42-48.
[25] Deena, W., Sharma, S.K., Attri, B.L. (2013). Evaluation of suitability of different media for drying of chrysanthemum flowers in mechanical dehydrator. Journal of Hill Agriculture. 4(2), 94-97.
[26] Raol Jaydipsinh B., Kumpavat Mahendrasinh T., Vyas D.M. (2013). Drying characteristics of rose flowers. Journal of Agricultural Engineering. 50(1), 39-46.
[27] Trinklein, D.H. (2010). Drying Flowers and Foliage for Arrangements. Horticultural MU Guıde, Published by University of Missouri Extention: 1-6. https://mospace.umsystem.edu/xmlui/bitstream/handle/10355/10061/DryingFlowersFoliage.pdf?sequence=3&isAllowed=y
[28] Chen, W., Gast, K.L.B., Smithey, S. (2000). The effects of different freeze-drying processes on the moisture content, color and physical strength of roses and carnations. Scientia Horticulturae. 84(3/4), 321-332.
[29] Hahn, F., Hernandez, G., Hernandez, J., Perez, C., Vargas, J. M. (2011). Optimization of roselle drying time and drying quality. Canadian Biosystems Engineering. 53, 3.1-3.8.
[30] Dilta, D. S., Sharma, B. P., Baweja, H. S., Kashyap, B. (2011). Flower drying techniques – A review. International Journal of Farm Sciences. 1(2), 1-16.
[31] Singh, A., Shah, R.R., Dhaduk, B.K. (2004). Study of dehydration techniques of zinnia. Indian Journal of Plant Physiology. 9(4), 383-387.
[32] Chua, K.J., Mujumdar, A.S., Chou, S.K., Hawlader, M.N.A., Ho, J.C., (2000). Convectıve drying of banana, guava and potato pieces: Effect of cyclical variations of air temperature on drying kinetics and color change. Drying Technology. 18(4&5).
[33] Doymaz, I., Tugrul , N., Pala, M. (2006). Drying characteristics of dill and parsley leaves. Journal of Food Engineering. 77 (3), 559–565.
[34] Demirhan, E., Ozbek, B. (2009). Color change kinetics of microwave-dried basil. Drying Technology. 27(1), 156-166.
[35] Anonymous, (1996). CIE L*a*b* Color scale. Applications note-insight on color, HenterLab. July 1-15, 8: 1-4.
[36] Maskan, M. (2000). Microwave/air and microwave finish drying of banana. Journal of Food Engineering. 44(2), 71-78.
[37] Saldamlı, I., Saldamlı, E. (2004). Gıda endüstrisi makineleri. Savaş Yayınları, 547 s. Ankara, (in Turkish).
[38] Falade, K.O., Aworh, O.C. (2004). Adsorption ısotherms of osmo-oven dried African star apple (Chrysophyllum albidum) and African mango (Irvingia gabonensis) slices. European Food Research and Technology. 218, 278-283.
[39] Ayrancı, E., Duman, O. (2005). Moisture sorption ısotherms of cowpea (Vigna unguiculata L.Walp) and its protein isolate at 10, 20 and 30°C. Journal of Food Engineering. 70(1), 83-91.

Received: **04.04.2018**
Accepted: **24.09.2018**

CORRESPONDING AUTHOR

Fusun Hasturk-Sahin
Tekirdag Namik Kemal University, Vocational School of Hayrabolu, Department of Agricultural Machinery, Tekirdag, Turkey

e-mail: fhasturk@nku.edu.tr

AUTHOR INDEX

Acaroz, U. 91
Aktas, T. 101

SUBJECT INDEX

AFS– GUIDE FOR AUTHORS

General

AFS accepts original papers, review articles, short communications, research abstracts from the entire sphere of Foodchemistry,-biology,- microbiology,- technology, -biotechnology and-management, furthermore, about residue analysis/ and ecotoxicology of contaminants.

Acceptance or no acceptance of a contribution will be decided, as in the case of other scientific journals, by a board of reviewers.Papers are processed with the understanding that they have not been published before (except in form of an abstract or as a part of a published lecture, review or thesis);that they are not under consideration for publication elsewhere; that their publication has been approved by all co-authors, if any, as well as- tacitly or explicitly- by the responsible authorities at the institute where the work has been carried out and that, if accepted, it will not be published elsewhere in the same form, in either the same or another language, without the consent of the copyright holders.

Language

Papers must be written in English. Spelling may either follow American (Webster) or British (Oxford) usage but must be consistent. Authors who are less familiar with the English language should seek assistance from proficient colleagues in order to produce manuscripts that are grammatically and linguistically correct.

Size of manuscript

Review articles should not exceed 30 typewritten pages. In addition up to 5 figures may be included.

Original papers must not exceed 14 typewritten pages. In addition up to 5 figures may be included.

Short-Communications should be limited to 4 typewritten pages plus not more than 1 illustration.

Short descriptions of the authors, presentation of their groups and their research activities (with photo) should together not exceed I typewritten page.Short research abstracts should report in a few brief sentences (one-fourth to one page) particularly significant findings.Short articles by relative newcomers to the chemical innovation arena highlight the key elements of their Master and PhD-works in about 1 page.

Book Reviews are normally written in-house, but suggestions for books to review are welcome.

Preparation of manuscript

Dear Authors,

AFS is available both as printed journal and as online journal on the web. You can now e-mail your manuscripts with an attached file. Save both time and money.To avoid any problems handling your text please follow the instructions given below:

When preparing your manuscripts have the formula K/SS (Keep It Simple and Stupid) in mind.Most word processing programs such as MS-Word offer a lot of features. Some of them can do serious harm to our layout. So please do not insert hyperlinks and/or automatic cross-references, tables of contents, references, footnotes, etc.

1. Please use the standard format features of your word processor (such as standard.dotfor MS Word).
2. Please do not insert automatisms or secret link-ups between your text and your figures ortables. These features will drive our graphic department sometimes mad.
3. Please only use two fonts for text or tables
"Times New Roman" and for graphical presentations "Arial".
4. Stylesheets, text, tables and graphics in shade of grey
5. Turn on the automatic language detection inEnglish (American or British)
6. Please - check your files for viruses before you send them to us!!

Manuscripts should send to:parlar@wzw.tum.de
or:parlar@prt-parlar.de

Thank you very much!

STRUCTURE OF THE MANUSCRIPT

Title page: The first page of the manuscript should contain the following items in the sequence given:A concise title of the paper (no abbreviations). The names of all authors with at least one first namespelled out for every author.The names of Universities with Faculty, City andCountry of all authors.

Abstracts: The second page of the manuscript should start with an abstract that summarizes briefly the contents of thepaper (except short communications). Its length shouldnot exceed 150-200 words. The abstract should be as informative as possible. An extended repetition of the paper's title is not considered to be an abstract.

Keywords: Below the Summary up to 6 key words have to beprovided which will assist indexers in cross-indexing your article.

Introduction: This should define the problem and, if possible, the frame of existing knowledge. Please ensure that peoplenot working in that particular field will be able to understand the intention. The word length of the introductionshould be 150 to 300 words.

Materials and methods:
Please be as precise as possible to enable other scientiststo repeat the work.

Results: Only material pertinent to the subject must be included.Data must not be repeated in figures and tables.

Acknowledgements: Acknowledgements of financial support, advice orother kind of assistance should be given at the end of thetext under the heading "Acknowledgements". The names of funding organisations should be written in full.

References: Responsibility for the accuracy of references rests with the authors. References are to be limited in numberto those absolutely necessary.References should appear in numerical order in brackets and in order of their citation in the text. They should be grouped at the end of the paper in numerical order of appearance. Abbreviated titles of periodicals are to be used according to Chemical or Biological Abstracts,but names of lesser known journals should be typed in full.References should be styled and punctuated according to the following examples:

ORIGINALPAPERS:
l. Author, N.N. and Author, N.N. (Year) Full title of
the article. Journal and Volume, first and last page.

BOOK OR PROCEEDING:
2. Author, N.N. and Author, N.N. (Year) Title of the contribution.
In: Title of the book or proceeding. Volume (Edition
of klitor-s, ed-s) Publisher, City, first and last page

DOCTORALTHESIS:
3. Author, N.N. (Year) Title of the thesis, University and
Faculty, City

UNPUBLISHED WORK:
Papers that are unpublished but have been submitted to a journal may be cited with the journal's name followed by "in press". However,this practice is acceptable only if the author has at least receivedgalley proofs of his paper. In all other cases reference must be made to “unpublished work" or "personal communication".

Discussion and Conclusion: This part should interpret the results in reference to the problem outlined in the introduction and of relatedobservations by the author/s or others. Implications for further studies or application may be discussed. A conclusion should be added if results and discussion are combined.

Corresponding author: The name of the corresponding author with complete postal address