Quality Evaluation of Dried Red Chili (*Capsicum annuum* L) with Convection and Radiation Drying Methods

Evaluasi Mutu Cabai Merah Kering (Capsicum annuum L) dengan Metode Pengeringan Konveksi dan Radiasi

Ridwan Rachmat[1a] , Helmi Harris[2] , Amar Maruf [1], Aditia Ginantaka[1]

[1]Agroindustrial Department, Halal Food Science Faculty, Djuanda University, Jl. Tol Ciawi No. 1, Ciawi, Bogor 16720.
[2]Food Technology Department, Halal Food Science Faculty, Djuanda University, Jl. Tol Ciawi No. 1, Ciawi, Bogor 16720.
[a]Korespondensi: Ridwan Rachmat, E-mail: rdwn2000@gmail.com

Diterima: 15 – 05 – 2023, Disetujui: 31 – 08 - 2023

ABSTRACT

Changes in the enzyme activity in chili that cause shrinkage or wrinkles during storage, transport, and fresh chili packing can reduce the market price. The objective of this study was the objective of this research is quality evaluation of dried red chili (capsicum annuum l) with convection and radiation drying methods. used a randomized block design consisting of several treatments, namely: 1). Sunlight; 2). Oven 50oC; 3). Oven 60oC; 4). Far Infrared Rays (FIR) 50 oC; 5). Far Infrared Rays (FIR) 60oC. Each treatment was repeated 3 times, the repetition effect as a group in order to get 15 experimental units. The material used in this study was red chili (*Capsicum annuum)*. The equipment used Far Infrared Ray (FIR) dryer, electrical oven, and equipment for analysis. This study employed a randomized block design consisting of 5 drying treatments with 3 replications for each treatment. This study showed that the use of FIR dryer at 50°C for drying red chilies gave the best drying time (11 hours), compares with sun drying (38 hours), and oven 50°C (46 hours). The rehydration property of the water content produced is also not much different from an oven dryer at 60°C (39 hours) and sun drying. Drying with FIR caused loss of volatile more than the oven method, however drying time for FIR dryer at 50oC and 60oC were shorter. Air quality levels, ash levels, VRS, and the yield obtained was not significantly different from the oven dryer which took longer drying time. Far Infrared dryer (FIR) and sun drying are radiation drying method, and electric oven as a convection method can provide the best results.

Key words: convection drying, FIR drying, red chili, radiation drying, sun drying

ABSTRAK

Perubahan aktivitas enzim pada cabai menyebabkan penyusutan atau kerutan selama penyimpanan, pengangkutan, dan pengemasan cabai segar sehingga harga pasar cenderung turun. Tujuan dari penelitian ini adalah untuk mengetahui perubahan yang terjadi pada proses pengeringan. Bahan yang digunakan dalam penelitian ini adalah cabai merah (*Capsicum annuum*). Peralatan yang digunakan adalah pengering *Far Infrared Ray* (FIR), oven listrik, dan peralatan untuk analisis. Penelitian ini menggunakan rancangan acak kelompok yang terdiri dari 5 perlakuan pengeringan dengan 3 ulangan untuk setiap perlakuan. Hasil penelitian menunjukkan bahwa penggunaan pengering FIR 50°C untuk pengeringan cabai merah memberikan waktu pengeringan terbaik (11 jam), dibandingkan dengan pengeringan matahari (38 jam), dan oven 50°C (46 jam). Sifat rehidrasi kadar air yang dihasilkan juga tidak jauh berbeda dengan pengering oven pada suhu 60°C (39 jam) dan pengeringan matahari. Pengeringan dengan FIR lebih banyak menyebabkan kehilangan volatil dibandingkan dengan metode oven, namun waktu pengeringan untuk pengering FIR pada suhu 50°C dan 60°C lebih singkat. Kadar kualitas udara, kadar abu, VRS, dan rendemen yang diperoleh tidak berbeda nyata dengan oven dryer yang membutuhkan waktu pengeringan lebih lama. Pengering Inframerah Jauh (FIR) dan pengeringan matahari merupakan metode pengeringan radiasi, dan oven listrik sebagai metode konveksi dapat memberikan hasil terbaik.

Kata Kunci: cabai merah, FIR drying, sun drying, convection drying, radiation drying.

Rachmat, R., Haris, H., Ma'ruf, A., & Ginantaka, A. (2023). Quality Evaluation of Dried Red Chili (Capsicum annuum L) with Convection and Radiation Drying Methods. *Jurnal Agroindustri Halal,* 9(2), 167 – 174.

INTRODUCTION

Red pepper or red chili (*Capsicum annuum* L) is one of the most important horticultural products in Indonesia. After harvest, the chili easily deteriorated. In general, the damage caused by several things, such as decomposition by bacteria or fungi, changes in enzyme activity that causes shrinkage or wrinkles, as well as damage during storage, packing, and transport of fresh chilies due to inadequate handling (Darvishi *et al.*, 2014). Red chili has a fairly short shelf life i.e., around 5 days. When the storage temperature of 5-10^{o}C and 85-90% humidity, red chili can last 10 days. Given this, it is necessary to preserve that can longer chili shelf life to get a higher price. One of the methods to prolong chili shelf life is the drying process. Dried chili peppers can be stored longer and also be more concise. This could minimize space in the container, so it gave more efficient packing and transporting facilities.

With the drying process, the production of abundant chilies can be secured so that the prices remain stable. The availability or stock of dry chili is also in accordance with the demands of instant food industry. Red chili is an annual plant. When immature, it has dark green color, ovoid-shaped and solitary flowers with white petals. The fruit usually have a moderate to very spicy flavor. Fruit shape is long and straight (big chili), or sleek and kinky (curly chili). Light green fruit color changes to dark green when young and turn into red when it is mature (Olawoye *et al.,* 2017). The main components of red chili are carbohydrates, protein, fat and fiber. The more mature, the more amount of these components (Quraishi *et al.,* 2021).

According to Lilies & Van de Fliert (2014), the main component in chili spicy flavor is capsaicin (69%) and dihidrocapsaicin (22%), while the other components are non-dihidrocapsaicin (7%), homocapsaicin (1%), and homo-dihidrocapsaicin (1%). The molecular formula of capsaicin is $C_{18}H_{27}NO_3$. Properties of capsaicin is colorless, odorless, melts at 65 ^{o}C and will evaporate at higher temperatures. The chili character such as spicy flavor and color vary from variety to variety (Muchtadi, 2000). The proportion of color in red pepper is 70-80% red and 20-30% orange (Gupta *et al.*, 2018). The color of chili is due to the carotenoid pigments that vary in color from yellow, orange to dark red.

Chili is usually used as seasoning and flavoring and used as a medicine *(Rabha et al.,* 2017). In the tropical regions, chili has been used as an important commodity. Indonesian chili was exported to other countries such as Singapore, Since the short supplies of domestic production and higher demand for consumption, Indonesia has to import it. Cessation of export of dried chili is caused also by the low quality of Indonesian chili which did not fulfill the international market demand. One factor that contributed to improve the low quality of chili was use of traditional drying method and untimorous sorting process.

Postharvest handling of chili must be done carefully to reduce the loss. Loss and shrinkage in Indonesia chili quality and quantity has reached 25-40% (Quraishi *et al.,* 2021). This relates to the inadequate handling in addition to unfavorable tropical nature. Therefore, we need technology to reduce loss and damage that were safe for consumption. As tropical horticultural commodities were easily damaged, the treatment process must be able to maintain or minimize changes in nutritional content, vitamins, aroma, flavor and other quality properties.

Losses which may be incurred as a result of drying, among others, the occurrence of chemical, physical changes, and the decline in the quality of certain agricultural products need additional treatment before being dried. According to Guo *et al.* (2014) the quality of the resulting dried chili in the dryer cabinet with fuel type "LPG" has a water content of 10.8% for air temperature dryer 45^{o}C, 16.3% for drying air temperature of 50^{o}C and 12,1% for drying air temperature of 55^{o}C. When compared with the quality requirements of dried chili according to Standard Indonesian Trade (SP-56-1987) (Mihindukulasuriya & Jayasuriya,

2015). The quality of dried chili peppers eligible dried drying process results in dryer temperature 45^{o}C.

Far Infrared technology (FIR) is a technology that is currently popular for radiation drying systems. The tool also has implemented a temperature control system, lap timer, dryer machine (FIR) that can be used for drying various agricultural products. This machine has a capacity of 5 kg LPG fueled with an average consumption of 0.25 kg/h and has a temperature range from 0 - 150 °C. FIR technology is recognized to lower the moisture content of materials in relatively short time compared with other drying technologies and does not depend on the season. The objective of this research is quality evaluation of dried red chili (capsicum annuum l) with convection and radiation drying methods.

MATERIALS AND METHOD

Materials

The study was conducted at the Postharvest Research Laboratory, Center for Agricultural Postharvest Research and Development, Ministry of Agriculture, Karawang, West Java. This study used red chili (*Capsicum annuum* L.) and the drier were used in this study as Far Infrared Rays (FIR), oven. The equipment for analysis includes employed Chromameter, Moisture tester, measuring cups, stirrers, glass tubes, digital scales, pipettes, knives, filter paper, test tube lids along with shelves, goblet, crankcase, volumetric pipette, scissors, petri dishes, knives (chopper), cutting board, aluminum cup, porcelain cup, desiccator.

Methods

The research method used a randomized block design consisting of several treatments, namely: 1). Sunlight; 2). Oven 50^{o}C; 3). Oven 60^{o}C; 4). Far Infrared Rays (FIR) 50 ^{o}C; 5). Far Infrared Rays (FIR) 60 ^{o}C. Each treatment was repeated 3 times, the repetition effect as a group in order to get 15 experimental units. The steps of process for drying red peppers showed in Figure 1. Fresh chili was obtained from the farmer at Lembang horticultural farm; then sorting, trimming, and weighing. Chili was cut in half and then soaked in $Na_2S_2O_5$ solution 0, 2% for 2-4 minutes then drained. Chili was blanched in hot water at a temperature of 60-80 ^{o}C for 2 minutes and then drained. After that, chili was dried. The initial water content of chili was measured using moisture tester. The dryer (Far Infrared) or oven, then was turned on until reach the require temperature, except for sun drying because drying temperature cannot be controlled. The weight of each treatment was measured every 60 minutes until the material did not change significantly in a constant weight.

Drying Methods

1) Drying in the sun was a method that depended on the weather. Sun drying was conducted from 7 am to 4 pm in the field by using a zinc container. Drying was considered complete when the water content showed no significant changing (equilibrium) by weighing each ingredient chili once an hour.
2) Employing the electric oven for drying, the steps are: chili was sort, trim and then weight. The 300 g chili then was blanched. The oven was set to desired temperature. Chili was placed in containers made of the type of plate and prepared in accordance with the rack in the oven. Drying was considered complete when the water content showed no significant change (equilibrium) by weighing ingredients red pepper every hour.
3) Far Infrared was a running dryer with the 40 cm depth, 3 m length, and the distance of radiation source was 18 cm, with temperatures ranging from 40-150 ^{o}C. Air velocity was 1.72 m/s, with a capacity of 2.5 tool kg/hour. Heat source for FIR were LPG with gas consumption 0.25 kg/hour. Chili was sort, trim and then weight. Then 600 g chili then blanched. Set the desired temperature and then put chili in the containers. Drying was

considered complete when the water content showed no significant change (equilibrium) by weighing each ingredient chili every hour (Getahun et al., 2021).

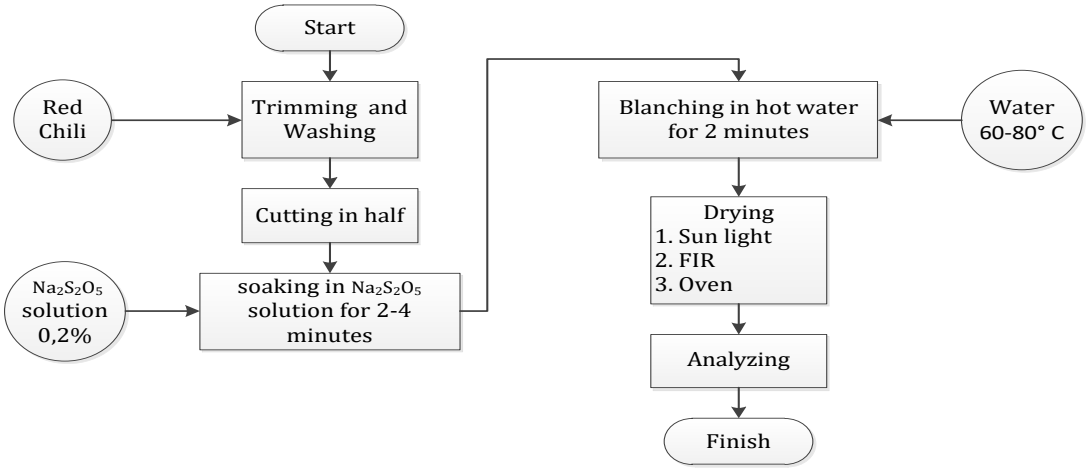

Figure 1. The preparation process of red pepper drying experiment.

RESULTS AND DISCUSSION

The oven drying for chili took relatively longer than using Far Infrared and sun drying. showed the decreased of water content during sun drying. The water content declined slowly at the stage of earlier drying at initial to 60 minutes for all treatments. In the process of water content reduction by sun drying (Figure 2), slower rate of decline in water levels starting from 75.60% to 68.96% for 300 minutes. It was because the material still fresh. The reduction of water content became slowly in the minutes of 1200 (19.77%) to 2280 (8.07%), while the rapid decrease in water levels starting from 300 minutes (68.96%) to 660 (57.51%). Then the decrease of water content became faster in the minutes of 720 (55.66%) to 1140 (20.58%).

In this study, the process of drying chili using sun drying takes about 2 days under sunny conditions, with average temperatures ranging from 38°C. The drying was conducted repeatedly as the efficient time for drying was starting from 8 to 9 am and removed at 4 to 5 pm. Dried chili was placed in a desiccator and the next day removed from desiccator and dried again until the results of the weighing of dried red chili has not changed.

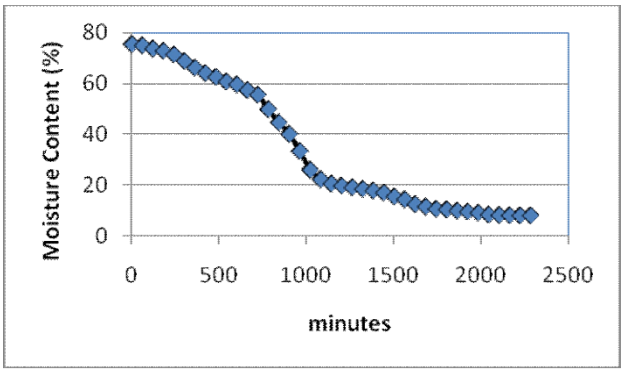

Figure 2. The water content decreased during chili sun drying process

Figure 3 showed that dryer using FIR caused slowly water content decline, that occured from minute 0 (75.47%) to 60 minutes (69.94%) at a temperature of 50 °C and 60 °C at a temperature ranging from 0 minutes (75.64%). After that, the water content slowly declined at a temperature of 50 °C at minute 480 (8.03%) to 660 minutes (5.99%), while at temperature 60 °C the water content slowly declined from 360 minutes (9.31%) to 540 minutes (6.09%). The rapid decrease in water content using FIR dryer occurred from 60

minutes (69.94%) to 420 minutes (13.02%) at temperature of 50 ^{o}C, while at temperature 60 ^{o}C water levels decrease rapidly occurs in minute 60 (67.07%) to 360 minutes (9.31%). That was because the heat gained by material to remove water came from the blast wave infrared heat where temperature could be set and could be maintain the continuity. This was the advantage of the FIR drying method compared with the sun-drying method.

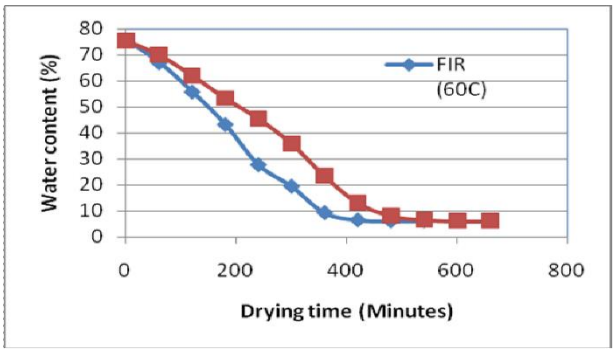

Figure 3. The water content decreased during chili drying process using FIR.

Figure 4. showed that dryer using oven at temperature 50 ^{o}C, water levels slowly declined from minute 0 (75.31%) to minute 1320 (48.83%) and then repeated from minute 2460 (9.00%) to minute 2760 (6.25%), while at a temperature 60 ^{o}C the water levels slowly declined started from minute 0 (75.61%) to minute 1020 (58.77%), and then in few minutes occur slowly declined in water levels starting from 2040 minutes (8.96%) to minute 2340 (4.02%). While in the dryer oven at temperature 50 ^{o}C rapid decline in water levels occur on minut 1380 (46.97%) to minute 2400 (10.08%), while at a temperature of 60 ^{o}C the rate of water level decline rapidly starting from minut 1080 (57.10%) to minute 2340 (4.02%).

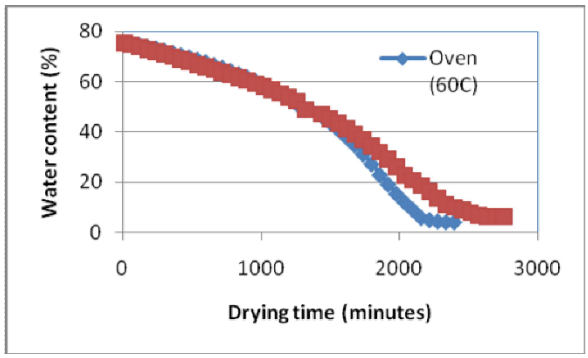

Figure 4. The water content decreased during drying chili using oven method.

Water Content

For the observational data of water content of red peppers was presented in Table 1. Based on the analysis of variance is known that the drying methods where the apparatus temperature was set up, gave a significant influence on the results of the water content of red chili. Results of further testing of LSD on 5% level are presented in Table 1.

Table 1. Effect of drying methods on water content of dry red chili.

No.	Drying Methods	Water Content (%)
1	Fresh Chili	75,64 **a**
2	Sun Drying	8,12 **b**
3	Oven 50 ^{0}C	6,21 **c**
4	Oven 60 ^{0}C	4,19 **d**
5	FIR 50 ^{0}C	6,1 **c**
6	FIR 60 ^{0}C	5,83 **c**

The numbers followed by the same letter are not significantly different at 5% level of LSD test.

The Table above showed that the water content of dried red chili in this study ranged between (8.12%) to (4.19%). Sun drying method compared to drying method using oven at 60 ^{o}C, oven at 50 ^{o}C, and FIR 50 ^{o}C, FIR 60 ^{o}C showed a significant difference on water content. Whereas the oven treatment at 50 ^{o}C compared with the FIR 50 ^{o}C and FIR 60 ^{o}C did not show significant differences. Sun drying treatment resulted in a relatively high-water content, it was expected that the intensity of light at the time of drying is not constant, nor drying temperature could not be well controlled due to night and day light. While the lowest yield was obtained on treatment of 60 ^{o}C oven because it allegedly used a high temperature that cause the water content in red chili missing in high level.

Ash Levels

Based on the analysis of variance is known that treatment with a drying apparatus specified temperature gives a significant influence on the results of the water content of red chili. Table 2 showed that treatment of drying in the sun when compared with oven 50 ^{o}C and 60 ^{o}C and FIR 60 ^{o}C had significantly difference in ash level, but the treatment of sun drying compared to FIR 60 ^{o}C showed no significant different as well as between treatment oven 50 ^{o}C compared with the oven 60 ^{o}C, 50 ^{o}C and FIR 60 ^{o}C. The result also showed that the lowest ash content results from the FIR treatment of 50 ^{o}C (4.830%), while the highest ash level was obtained from the treatment of sun drying (6.310%). High ash level of sun drying treatment was suspected that during the drying process much dirt or sand are carried by natural factors such as wind so the ash level of the water molecules in the dried red chilies increased. This is in accordance with the opinion of Fadhilatunnur et al., (2022), that stated that during the drying process has been occurring bond component decomposition of water molecules (H_2O) and also superimposed on the content of sugar, fat and protein.

From the results of further testing of LSD can be seen that the ash level was tested on dried red chili was under the ash level standard for seasonings, spices and vegetables with highest levels of ash was 6.31%. The ash level maximum for industry based on Indonesian industry standards is 7.1%, but for the international standard the ash level was below 5.5% Thus the ash level of the dried red chili from oven at temperature 50 ^{o}C, 60 ^{o}C, and FIR 50 ^{o}C, 60 ^{o}C suitable to the international standards.

Table 2. Effect of drying methods on ash level of dry red chili.

No.	Drying Methods	Ash Level (%)
1	Fresh Chili	1,33 **c**
2	Sun Drying	6,31 **a**
3	Oven 50 ^{0}C	4,96 **b**
4	Oven 60 ^{0}C	5,11 **b**
5	FIR 50 ^{0}C	4,83 **b**
6	FIR 60 ^{0}C	5,52 **ab**

The numbers followed by the same letter are not significantly different at 5% level of LSD test.

Volatile Reducing Substance (VRS)

Based on the results of analysis of variance at 5% level of LSD test, it noted that the drying treatment was affected significantly difference on VRS as presented in Table 3. The sun drying treatment compared to oven drying at temperature 50 ^{o}C, and FIR 50 ^{o}C, 60 ^{o}C showed significant differences on VRS, while the sun drying compared to oven at 60 ^{o}C showed highly significant differences on VRS. Sun drying treatment using oven 50 ^{o}C compared to FIR 50 ^{o}C, 60 ^{o}C showed no difference. The highest VRS value obtained from treatment oven 60 ^{o}C while the lowest yield was obtained from the treatment of sun drying. Low results obtained from the treatment of sun drying suspected because of the high permeability levels causing many losses on volatile components, thus VRS values also decreased. While high VRS results of

treatment of oven 60 ^{o}C alleged that the dryer oven is able to withstand the loss of volatile compounds resulting from the high gas permeability, which contained in the dried red chilies.

Table 3. Effect of drying methods on Volatile Reducing Substance (VRS) dried red chili.

No.	Drying Methods	VRS (ppm)
1	Fresh Chili	2,01 **d**
2	Sun Drying	3,99 **c**
3	Oven 50 ^{0}C	6,20 **b**
4	Oven 60 ^{0}C	6,84 **a**
5	FIR 50 ^{0}C	5,97 **b**
6	FIR 60 ^{0}C	6,17 **b**

The numbers followed by the same letter are not significantly different at 5% level of LSD test.

The further analysis of variance LSD test at 5% level were presented Table 4. Recovery yield value is important to note, because there was a relation to the economic value of dried red chili that will be used. The drying treatment effected significantly and high significantly on recovery yield of dried red chili (Sudaro & Ratriningsih, 1997). Sun drying treatment compared to oven drying at temperature 50 ^{o}C, 60 ^{o}C was high significantly difference on recovery yield of dried red chili, whereas the oven drying at temperature 50 ^{o}C (Handayani et al., 2022), compared to oven 60 ^{o}C, FIR 60 ^{o}C and FIR 50 ^{o}C only showed significantly differences. While between oven drying 60 ^{o}C treatment compared to FIR 50 ^{o}C treatment showed no difference, as well as the FIR 50 ^{o}C treatment compared to FIR 60 ^{o}C did not difference. The result showed that recovery yield values obtained in some drying methods (oven 50 ^{o}C, 60 ^{o}C and FIR 50 ^{o}C, 60 ^{o}C) ranged between 19.0% - 22.03%. This recovery yield was much higher than drying using unlight (17.27%). Low recovery yield values obtained by sun drying was alleged because of during drying process many chili seeds was scattered.

Table 4. Effect of drying methods on the recovery yield of dried red chili.

No.	Drying Methods	Recovery yield (%)
1	Fresh Chili	0 **e**
2	Sun Drying	17,27 **d**
3	Oven 50 ^{0}C	22,03 **a**
4	Oven 60 ^{0}C	19,90 **b**
5	FIR 50 ^{0}C	19,60 **bc**
6	FIR 60 ^{0}C	19,02 **c**

The numbers followed by the same letter are not significantly different at 5% level of LSD test

CONCLUSION

This study suggested that the use of the Far Infrared dryer at temperature of 50 ^{o}C to dry red chili gave more time efficiency (11 hours) compared to sun drying (38 hours) and drying using oven at temperature 50 ^{o}C (46 hours). The water content of the dried chili was not much different from oven dryer at 60 ^{o}C (39 hour) and sun drying. The ash level between FIR and oven drying at 50 ^{o}C were not different, but for the result of VRS level dominated by oven dryer at 60 ^{o}C (6.84 ppm) and 50 ^{o}C (6.20 ppm), then followed by Far Infrared Rays at 60 ^{o}C (6.17 ppm), 50 ^{o}C (5.97 ppm) and followed by sun drying (3.99 ppm). The FIR dryer method related to the open air that caused lost many of volatile content than that oven drying. The yield recovery by employing oven at temperature 50 and 60^{o}C were 22.03 and 19.90 g respectively but it was not significantly different compared with FIR at 50 and 60 ^{o}C were 19.60 and 19.02 g respectively. This study expressed that a shorter drying time obtained from

FIR 50 ^{o}C, and drying method using FIR 60 ^{o}C resulting water content, ash level, VRS, and yield recovery obtained was not much different from the oven dryer.

REFERENCES

Darvishi, H., Asl, A. R., Asghari, A., Azadbakht, M., Najafi, G., & Khodaei, J. (2014). Study of the drying kinetics of pepper. *Journal of the Saudi Society of Agricultural Sciences*, *13*(2), 130–138. https://doi.org/10.1016/j.jssas.2013.03.002

Fadhilatunnur, H., Subarna, Murtadho, Z., & Muhandri, T. (2022). Pengeringan cabai merah (capsicum annuum l.) dengan kombinasi oven microwave dan kipas angin. *Jurnal Mutu Pangan : Indonesian Journal of Food Quality*, *9*(1), 26–35. https://doi.org/10.29244/jmpi.2022.9.1.26

Getahun, E., Delele, M. A., Gabbiye, N., Fanta, S. W., & Vanierschot, M. (2021). Studying the drying characteristics and quality attributes of chili pepper at different maturity stages: Experimental and mechanistic model. *Case Studies in Thermal Engineering*, *26*, 101052. https://doi.org/10.1016/j.csite.2021.101052

Guo, X. hui, Xia, C. yan, Tan, Y. rong, Chen, L., & Ming, J. (2014). Mathematical modeling and effect of various hot-air drying on mushroom (lentinus edodes). *Journal of Integrative Agriculture*, *13*(1), 207–216. https://doi.org/10.1016/S2095-3119(13)60265-8

Gupta, S., Sharma, S. R., Mittal, T. C., Jindal, S. K., & Gupta, S. K. (2018). Effect of different drying techniques on quality of red chilli powder. *Indian Journal of Ecology*, *45*(2), 402–405.

Handayani, S. U., Mujiarto, I., Siswanto, A. P., Ariwibowo, D., Atmanto, I. S., & Mustikaningrum, M. (2022). Drying kinetics of chilli under sun and microwave drying. *Materials Today: Proceedings*, *63*, S153–S158. https://doi.org/10.1016/j.matpr.2022.02.119

Lilies, C., & Van de Fliert, E. (2014). *Pengolahan Terpadu Pada Cabai (Capsicun Spp.) di Daratan Rendah Tropis*. Bentang.

Mihindukulasuriya, S. D. F., & Jayasuriya, H. P. W. (2015). Drying of chilli in a combined infrared and hot air rotary dryer. *Journal of Food Science and Technology*, *52*(8), 4895–4904. https://doi.org/10.1007/s13197-014-1546-9

Muchtadi. (2000). *Teknologi Proses Pengolahan Pangan*. Direktorat Jenderal Pendidikan.

Olawoye, B. T., Kadiri, O., & Babalola, T. R. (2017). Modelling of thin-layer drying characteristic of unripe Cardaba banana (Musa ABB) slices. *Cogent Food and Agriculture*, *3*(1). https://doi.org/10.1080/23311932.2017.1290013

Quraishi, A., Champawat, P. S., Jain, S. K., & Dhake, K. (2021). Drying characteristics of green chilli and quality attributes of developed powder. *The Pharma Innovation Journal*, *10*(9), 1127–1133.

Rabha, D. K., Muthukumar, P., & Somayaji, C. (2017). Experimental investigation of thin layer drying kinetics of ghost chilli pepper (Capsicum Chinense Jacq.) dried in a forced convection solar tunnel dryer. *Renewable Energy*, *105*, 583–589. https://doi.org/10.1016/j.renene.2016.12.091

Sudaro, Y., & Ratriningsih, D. A. (1997). *Pengeringan Cabai*. Penebar Swadaya.