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Analysis Of Differences In Onion Drying Systems With Steam Fan Collectors And Ovens

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Abstract

This study aims to analyze the differences System Drying Shallots With Collector Fan Steam and Oven. Based on results study drying onion red using a drying oven with method displacement hot convection and radiation, then can concluded as following Process drying cause occurrence decline heavy material in a way gradually from 9 kg to 4.4 kg. Weight loss heavy happen Because water content in material evaporate during the heating process. Transfer hot convection happen consequence flow air heat directly in the oven about surface material. The size displacement hot convection increase along increase oven temperature. Transfer hot radiation happen through radiance hot from element oven heater towards materials. Radiant heat help speed up the evaporation process water content in onions red. Calculation results show that the more tall temperature drying, then displacement the heat that occurs the more big so that the drying process ongoing more fast. Use of drying oven proven effective in lower moisture content of the material and speed up the drying process onion red..

Keywords: Analysis, Difference, System Drying, Red Onion, Collector Fan Steam, Oven

INTRODUCTION

Onion red is one of the commodities horticulture the flagship that has role important in life society, especially as material base in various cooking (Gul et al., 2026). In addition, onions red also has mark high economy Because his continued requests increase good in local market and national. However, onions red including material results easy farming damaged

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(perishable), so that need handling proper post- harvest For guard quality and extend age save (John et al., 2023).

One of factor main cause damage to onions red is height water content contained in it. Water content of onions fresh red in general range between 80% to 85%. High water content This cause onion red is very vulnerable to growth microorganisms like bacteria and fungi, as well as accelerate the decay process. Therefore that, is necessary something method effective preservation For lower water content up to reach safe level (El-Mesery et al., 2026).

Drying is one of the method the most common preservation used in processing results agriculture. Drying process aim For reduce water content in material so that activity microorganisms can pressed and reacted damaging chemicals can slowed down. In addition, drying can also be reduce weight and volume of materials, so make it easier in the storage and distribution process (Fernandes & Tavares, 2024).

In development technology, methods drying has experience various innovation. In general, method drying can differentiated become drying natural and drying artificial. Drying experience usually done with utilise ray the sun, but method This own Lots limitations like dependence to weather, time long drying, as well as risk contamination. Therefore that, drying artificial become more alternatives effective and efficient (Kokate et al., 2022).

Two methods drying frequent artificial used is system drying with collector fan steam and oven. System collector fan steam Work with utilise source heat transferred through air media or steam the heat then circulated use fan. System This allows distribution more heat evenly so that the drying process can ongoing more fast and efficient. In addition, the system this can also designed For utilise energy alternative like hot combined sun with fan as driving force circulation air (Abdalla et al., 2023).

On the other hand, the method drying using an oven is one of the the most common method used Because his abilities in produce stable and controlled temperature. The oven works with method heat room closed use energy electricity or material burn certain, so that the temperature inside can arranged in accordance with drying process requirements. With condition stable temperature, drying process can ongoing in a way consistent and productive product with better quality uniform

Although second method the own the same goal, namely reduce water content in materials, there are difference fundamental in mechanism work, efficiency energy, time drying, as well as quality results obtained. System collector fan steam tend more economical energetic and friendly environment, however Possible own limitations in control precise temperature. While that, the oven has superiority in control higher temperature good, but need more energy

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size and cost more operational tall

Therefore that 's important For do analysis comparison between second method drying the For know the advantages and disadvantages of each method. This analysis expected can give clear picture about which method is better effective, efficient and appropriate For used in drying onion red, good in scale House ladder and industry (Getie et al., 2025).

With existence study this, it is hoped can obtained accurate information about performance second system drying said, so that can become base in taking decision for farmers, actors business, as well as researchers in choose method proper drying.

METHODOLOGY

This research was conducted at: :11-04-2026. Venue : Engineering Workshop/Campus. The selection of the research location was based on the availability of drying equipment in the form of a steam fan collector and oven, as well as the ease of conducting observations and measurements. A steam collector dryer is an artificial drying system that utilizes heat from air or steam generated by a collector, which is then distributed evenly over the material using a fan (blower). This system operates on the principle of hot air circulation, accelerating the evaporation of water from the material being dried (Zewdie et al., 2022).

In this system, the collector serves as a heat source, which can be solar, electrical, or fuel. The generated heat flows through air ducts and is assisted by a fan to distribute the heat evenly throughout the drying chamber (Zewdie et al., 2022). The continuous airflow removes water vapor from the material, making the drying process more effective.

This tool is generally used in drying agricultural products such as shallots, chilies, fish, and other products that require drying at moderate temperatures and even heat distribution. The steam fan collector dryer is a fairly efficient and economical drying system, especially for agricultural and small-scale businesses. Although it has limitations in temperature control, this tool remains a good alternative because it is energy efficient and environmentally friendly (Jeevarathinam et al., 2026).

A drying oven is a device used to reduce the moisture content of a material by heating it in a confined space using a heat source, such as electricity, gas, or other fuel. The drying process in an oven occurs through heat transfer by conduction, convection, and radiation, causing the water in the material to evaporate and escape through ventilation (Moradas & Sealongo, 2022).

Drying ovens are generally equipped with a thermostat that allows users to control the temperature as needed. With a closed system and stable temperature, the oven is capable of a more controlled and consistent drying process than natural drying methods.

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In agriculture and the food industry, ovens are often used to dry various ingredients such as shallots, chilies, fruits, and other processed products. Ovens are also widely used in research because they produce more accurate and uniform results (Chen et al., 2023).

Drying ovens are highly effective tools for the drying process because they provide stable temperatures and consistent results. However, they require significant energy costs, so consideration should be given to their use, especially on a large scale.

A digital scale is a tool for measuring the mass or weight of an object. It works using electronic sensors and displays the measurement results as numbers on a digital screen. These scales generally use a load cell that detects the pressure or force exerted on the object being weighed and then converts it into an electrical signal that is processed into a weight value (Younis et al., 2025).

Digital scales are extremely helpful in their use because they provide faster, more accurate, and easier-to-read results than manual scales. These tools are widely used in various fields, such as laboratories, industry, commerce, and research, including measuring the weight of ingredients like shallots during the drying process.

A stopwatch is a time-measuring instrument used to calculate the duration of an activity with a certain degree of accuracy, ranging from seconds to milliseconds. Stopwatches can be operated manually or digitally, and are usually equipped with buttons to start, stop, and reset the time measurement.

In the context of research, particularly in the shallot drying process, a stopwatch is used to record the drying time, the observation interval, and the time required for the material to reach a dry state. Accurate time measurements are crucial because they directly impact the analysis of drying rate and the efficiency of the method used (Planchard, 2024).

Recording tools such as books and writing utensils are simple yet crucial tools in research. Despite some limitations, these tools remain effective for directly and systematically recording data, especially in the field.

Fresh shallots are newly harvested horticultural bulbs that have not undergone any processing or preservation, retaining their high water content and natural physical and chemical properties. Fresh shallots generally have a water content of around 80%–85%, with a firm texture, thin outer skin, and a strong, distinctive aroma (Khater et al., 2025).

Fresh shallots are obtained directly from the harvest and are usually intact, with or without the outer skin. In this condition, the shallots are still physiologically active, so respiration and water evaporation still occur, which can affect their quality during storage (Antelm et al., 2023).

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Due to their high water content, fresh shallots are highly susceptible to damage, such as rotting, mold growth, and quality degradation due to microbial activity. Therefore, proper post-harvest handling, including drying, is essential to reduce water content and extend shelf life (Antelm et al., 2023).

RESULTS AND DISCUSSION

Convection Heat Formula

1. First Calculation

Drying Data

Time	Initial Weight	Final Weight	Oven Temperature Temperature Environment
09.00–10.00	9 kg	8.2 kg	60°C 30°C

Formula displacement hot convection :

$$Q = hA(T_s - T_\infty)$$

It is known that :

1. h = 15 \, W/m^2^\ circ C
2. $A = 1.2\ m^2$
3. $T_s = 60°C$
4. $T_\infty = 30°C$

Step 1: Substitute Data into Formula

Enter all mark to formula :

$$Q = 15 \times 1.2 \times (60 - 30)$$

Step 2: Calculate Difference Temperature

Reduce temperature surface with temperature environment :

$$60 - 30 = 30°C$$

So that formula become :

$$Q = 15 \times 1.2 \times 30$$

Step 3: Multiply the Values

First :

$$15 \times 1.2 = 1$$

Then :

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$$18 \times 30 = 540$$

The final result:

$$Q = 540 \text{ Watt}$$

So, the move hot convection that occurs in the drying process is of = 540 Watts.

2. Second Calculation

Drying Data

Time	Initial Weight	Final Weight	Oven Temperature Temperature Environment
10.00–11.00	8.2 kg	7.4 kg	65°C 32°C

Formula displacement hot convection :

$$Q = hA(T_s - T_\infty)$$

It is known that :

1. Coefficient convection (h)= 15 W/m²°C
2. Oven (A)surface area = 1.2 m²
3. Oven (T_s)temperature = 65°C
4. Temperature environment (T_∞)= 32°C

Step 1: Substitute Data into Formula

$$Q = 15 \times 1.2 \times (65 - 32$$

Step 2: Calculate Difference Temperature

$$65 - 32 = 33°C$$

So that :

$Q = 15 \times 1.2 \times 33$Step 3: Calculation

First :

$$15 \times 1.2 = 18$$

Then :

$$18 \times 33 = 594$$

Convection Heat Transfer Results

$$Q = 594 \text{ Watt}$$

So, the move hot convection that occurs is of = 594 Watts.

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3. Third Calculation.

Drying Data

Time	Initial Weight	Final Weight	Oven Temperature Temperature Environment
11.00–12.00	7.4 kg	6.5 kg	70°C 34°C

Formula displacement hot convection :

$$Q = hA(T_s - T_\infty)$$

It is known that :

1. Coefficient convection (h)= 15 W/m²°C
2. Oven (A)surface area = 1.2 m²
3. Oven (T_s)temperature = 70°C
4. Temperature environment (T_∞)= 34°C

Step 1: Substitute Data into Formula

$$Q = 15 \times 1.2 \times (70 - 34)$$

Step 2: Calculate Difference Temperature

$$70 - 34 = 36^\circ C$$

So that :

$$Q = 15 \times 1.2 \times 36$$

Step 3: Calculation

First :

$$15 \times 1.2 = 18$$

Then :

$$18 \times 36 = 648$$

Convection Heat Transfer Results

$$Q = 648 \text{ Watt}$$

So, the move hot convection that occurs is of = 648 Watts.

4. Calculation to four

Drying Data

Time	Initial Weight	Final Weight	Oven Temperature Temperature Environment
12.00–13.00	6.5 kg	5.7 kg	75°C 35°C

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Formula displacement hot convection :

$$Q = hA(T_s - T_\infty)$$

It is known that :

1. Coefficient convection (h)= 15 W/m²°C
2. Oven (A)surface area = 1.2 m²
3. Oven (T_s)temperature = 75°C
4. Temperature environment (T_∞)= 35°C

Step 1: Substitute Data into Formula

$$Q = 15 \times 1.2 \times (75 - 35)$$

Step 2: Calculate Difference Temperature

$$75 - 35 = 40°C$$

So that :

$$Q = 15 \times 1.2 \times 40$$

Step 3: Calculation

First :

$$15 \times 1.2 = 1$$

Then :

$$18 \times 40 = 720$$

Convection Heat Transfer Results

$$Q = 720 \text{ Watt}$$

So, the convection heat transfer that occurs is = 720 Watts.

5. Fifth calculation

Drying Data

Time	Initial Weight	Final Weight	Oven Temperature Temperature Environment
1:00–2:00 PM	5.7 kg	5.0 kg	80°C 36°C

Formula displacement hot convection :

$$Q = hA(T_s - T_\infty)$$

It is known that :

1. Coefficient convection (h)= 15 W/m²°C
2. Oven (A)surface area = 1.2 m²

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3. Oven (T_s)temperature = 80°C
4. Temperature environment (T_∞)= 36°C

Step 1: Substitute Data into Formula

$$Q = 15 \times 1.2 \times (80 - 36)$$

Step 2: Calculate Difference Temperature

$$80 - 36 = 44^\circ C$$

So that:

$$Q = 15 \times 1.2 \times 44$$

Step 3: Calculation

First :

$$15 \times 1.2 = 18$$

Then :

$$18 \times 44 = 792$$

Convection Heat Transfer Results

$$Q = 792 \text{ Watt}$$

So, the move hot convection that occurs is of = 792 Watts.

6. Calculation sixth

Formula displacement hot convection :

$$Q = hA(T_s - T_\infty)$$

It is known that :

1. Coefficient convection (h)= 15 W/m²°C
2. Oven (A)surface area = 1.2 m²
3. Oven (T_s)temperature = 85°C
4. Temperature environment (T_∞)= 37°C

Step 1: Substitute Data into Formula

$$Q = 15 \times 1.2 \times (85 - 37)$$

Step 2: Calculate Difference Temperature

$$85 - 37 = 48^\circ C$$

So that :

$$Q = 15 \times 1.2 \times 4$$

Step 3: Calculation

First :

$$15 \times 1.2 = 1$$

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Then :

$$18 \times 48 = 86$$

Convection Heat Transfer Results

$$Q = 864 \text{ Wat}$$

So, the move hot convection that occurs is of = 864 Watts.

Radiation Heat Formula

1. First Calculation

Drying Data

Time	Initial Weight	Final Weight	Oven Temperature Temperature Environment
09.00–10.00	9.0 kg	8.2 kg	60°C 30°C

It is known that :

1. Emissivity surface (ε)= 0.9
2. Stefan–Boltzmann (σ)constant =$5.67 \times 10^{-8}\, W/m^2K^4$
3. Oven (A)surface area = 1.2 m²
4. Temperature oven (T_1)surface = 60°C = 333 K
5. Temperature environment (T_2)= 30°C = 303 K

Formula displacement hot radiation :

$$Q = \varepsilon\sigma A(T_1^4 - T_2^4)$$

Step 1: Substitute Data into Formula

$$Q = 0.9 \times 5.67 \times 10^{-8} \times 1.2 \times (333^4 - 303^4)$$

Step 2: Calculate Rank Temperature

$$333^4 = 12.29 \times 10^9$$
$$303^4 = 8.43 \times 10^9$$

Difference temperature :

$$12.29 \times 10^9 - 8.43 \times 10^9 = 3.86 \times 10^9$$

Step 3: Calculation

$$Q = 0.9 \times 5.67 \times 10^{-8} \times 1.2 \times 3.86 \times 10^9$$
$$Q \approx 236 \text{ Watt}$$

Radiation Heat Transfer Results

$$Q = 236 \text{ Watt}$$

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So, the move hot radiation that occurs is of = 236 Watts.

2. Second Calculation

Drying Data

Time	Initial Weight	Final Weight	Oven Temperature Temperature Environment
10.00–11.00	8.2 kg	7.4 kg	65°C 32°C

It is known that :

1. Emissivity surface (ε)= 0.9
2. Stefan–Boltzmann (σ)constant =$5.67 \times 10^{-8}\ W/m^2K^4$
3. Oven (A)surface area = 1.2 m²
4. Temperature oven (T_1)surface = 65°C = 338 K
5. Temperature environment (T_2)= 32°C = 305 K

Formula displacement hot radiation :

$$Q = \varepsilon\sigma A(T_1^4 - T_2^4)$$

Step 1: Substitute Data into Formula

$$Q = 0.9 \times 5.67 \times 10^{-8} \times 1.2 \times (338^4 - 305^4)$$

Step 2: Calculate Rank Temperature

$$338^4 = 13.05 \times 10^9$$
$$305^4 = 8.65 \times 10^9$$

Difference temperature :

$$13.05 \times 10^9 - 8.65 \times 10^9 = 4.40 \times 10^9$$

Step 3: Calculation

$$Q = 0.9 \times 5.67 \times 10^{-8} \times 1.2 \times 4.40 \times 10^9$$
$$Q \approx 269 \text{ Watt}$$

Radiation Heat Transfer Results

$$Q = 269 \text{ Watt}$$

So, the move hot radiation that occurs is of = 269 Watts.

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3. Third Calculation

Drying Data

Time	Initial Weight	Final Weight	Oven Temperature
11.00–12.00	7.4 kg	6.5 kg	70°C

It is known that :

1. Emissivity surface (ε)= 0.9
2. Stefan–Boltzmann (σ)constant =$5.67 \times 10^{-8}\ W/m^2K^4$
3. Oven (A)surface area = 1.2 m²
4. Temperature oven (T_1)surface = 70°C = 343 K
5. Temperature environment (T_2)= 34°C = 307 K

Formula displacement hot radiation :

$$Q = \varepsilon\sigma A(T_1^4 - T_2^4)$$

Step 1: Substitute Data into Formula

$$Q = 0.9 \times 5.67 \times 10^{-8} \times 1.2 \times (343^4 - 307^4)$$

Step 2: Calculate Rank Temperature

$$343^4 = 13.84 \times 10^9$$
$$307^4 = 8.88 \times 10^9$$

Temperature difference:

$$13.84 \times 10^9 - 8.88 \times 10^9 = 4.96 \times 10^9$$

Step 3: Calculation

$$Q = 0.9 \times 5.67 \times 10^{-8} \times 1.2 \times 4.96 \times 10^9$$
$$Q \approx 304 \text{ Watt}$$

Radiation Heat Transfer Results

$$Q = 304 \text{ Watt}$$

So, the radiant heat transfer that occurs is of 304 Watts.

4. Fourth calculation

Drying Data

It is known that :

1. Emissivity surface (ε)= 0.9

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2. Stefan–Boltzmann (σ)constant =$5.67 \times 10^{-8}\, W/m^2K^4$
3. Oven (A)surface area = 1.2 m²
4. Temperature oven (T_1)surface = 75°C = 348 K
5. Temperature environment (T_2)= 35°C = 308 K

Formula displacement hot radiation :

$$Q = \varepsilon\sigma A(T_1^4 - T_2^4)$$

Step 1: Substitute Data into Formula

$$Q = 0.9 \times 5.67 \times 10^{-8} \times 1.2 \times (348^4 - 308^4)$$

Step 2: Calculate Rank Temperature

$$348^4 = 14.67 \times 10^9$$
$$308^4 = 9.00 \times 10^9$$

Difference temperature :

$$14.67 \times 10^9 - 9.00 \times 10^9 = 5.67 \times 10^9$$

Step 3: Calculation

$$Q = 0.9 \times 5.67 \times 10^{-8} \times 1.2 \times 5.67 \times 10^9$$
$$Q \approx 347 \text{ Watt}$$

Radiation Heat Transfer Results

$$Q = 347 \text{ Watt}$$

So, the radiant heat transfer that occurs is 347 Watts.

5. The fifth count

Drying Data

Time	Initial Weight	Final Weight	Oven Temperature Temperature environment
1:00–2:00 PM	5.7 kg	5.0 kg	80°C 36°C

It is known that :

1. Emissivity surface (ε)= 0.9
2. Stefan–Boltzmann (σ)constant =$5.67 \times 10^{-8}\, W/m^2K^4$
3. Oven (A)surface area = 1.2 m²
4. Temperature oven (T_1)surface = 80°C = 353 K
5. Temperature environment (T_2)= 36°C = 309 K

Formula displacement hot radiation :

$$Q = \varepsilon\sigma A(T_1^4 - T_2^4)$$

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Calculation Convection Heat Transfer

Transfer hot convection happen Because existence flow air heat on contact direct with surface material.

Formula displacement hot convection :

$$Q = hA(T_s - T_\infty)$$

Information :

1. Q= heat transfer rate (Watts)
2. h= convection coefficient
3. A= oven surface area
4. T_s= oven surface temperature
5. T_∞ambient temperature

Example Calculation Convection

It is known that :

1. h = 15 \, W/m^2^\ circ C
2. $A = 1.2\ m^2$
3. $T_s = 60°C$
4. $T_\infty = 30°C$

Substitute data to formula :

$$Q = 15 \times 1.2 \times (60 - 30)$$

Count difference temperature :

$$60 - 30 = 30°C$$

Then :

$$Q = 15 \times 1.2 \times 30$$
$$Q = 540 \text{ Watt}$$

So, convection heat transfer occurs of 540 Watts.

Calculation Radiation Heat Transfer

Transfer hot radiation happen through radiance wave hot from source oven heat towards material.

Formula displacement hot radiation :

$$Q = \varepsilon\sigma A(T_1^4 - T_2^4)$$

Information :

1. ε= surface emissivity
2. σ= Stefan–Boltzmann constant
3. A= surface area

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4. T_1= oven temperature
5. T_2= ambient temperature

Example Radiation Calculation

It is known that :

1. $\varepsilon = 0.9$
2. $\sigma = 5.67 \times 10^{-8}$
3. $A = 1.2\, m^2$
4. $T_1 = 333\, K$
5. $T_2 = 303\, K$

Data substitution :

$$Q = 0.9 \times 5.67 \times 10^{-8} \times 1.2 \times (333^4 - 303^4)$$

Calculation results :

$$Q \approx 236 \text{ Wat}$$

So, the move hot radiation that occurs of 236 Watts.

DISCUSSION

Based on results research, drying process using the oven shows decline heavy material from 9 kg to 4.4 kg. Weight loss heavy happen Because water content in onions red evaporate during the heating process (Mehmood et al., 2022).

Transfer hot convection happen consequence flow air heat directly in the oven about surface materials. The more tall oven temperature, then rate displacement hot convection the more big so that the drying process ongoing more fast (Wang et al., 2023).

In addition, the transfer hot Radiation also helps the drying process through radiance hot from element oven heater towards ingredients (Amir et al., 2025). Combination displacement hot convection and radiation cause water content of the material reduce in a way gradually (Mehmood et al., 2022).

Research result show that increased oven temperature from 60°C to 85°C capable speed up evaporation of water so that heavy material Keep going decreased with each hour of observation.

CONCLUSION

Based on results study drying onion red using a drying oven with method displacement hot convection and radiation, then can concluded as following :

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1. Drying process cause occurrence decline heavy material in a way gradually from 9 kg to 4.4 kg. Weight loss heavy happen Because water content in material evaporate during the heating process.
2. Transfer hot convection happen consequence flow air heat directly in the oven about surface material. The size displacement hot convection increase along increase oven temperature.
3. Transfer hot radiation happen through radiance hot from element oven heater towards materials. Radiant heat help speed up the evaporation process water content in onions red.
4. Calculation results show that the more tall temperature drying, then displacement the heat that occurs the more big so that the drying process ongoing more fast.
5. Use of drying oven proven effective in lower moisture content of the material and speed up the drying process onion red.

Suggestion

Based on results research that has been done, then the suggestions that can be given is as following :

1. Should done arrangement stable temperature during the drying process so that the results drying more evenly.
2. Further research expected use tool gauge more temperature and humidity accurate For get more data Good.
3. Need done study more carry on about influence variation temperature and time drying to quality onion the resulting red.
4. Use of drying oven with system circulation more air Good can increase efficiency of the drying process.

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