28

IR DRYING OF FISH AND FISHERY PRODUCTS

Aniesrani Delfiya, D.S.
Engineering Section
Email: ***delfy.lenin@gmail.com***

In recent years, infrared drying has gained popularity as an alternative drying method for foods. IR is electromagnetic radiation that is in the region of 0.78 – 1000μm. It is transmitted and absorbed by the food surface and gets changed into heat. Generally, the far-IR region (3 – 1000μm) is used for food processing since most of the food materials are having the ability to absorb IR in this region. IR radiation impinges on the surface of the material which has to be dried and penetrated into it. Absorption of radiation increases the molecular vibration inside the material and resulted in heat generation on both the inside and surface of the material concurrently (Sakai and Hanzawa, 1994). Faster heat generation inside the material increases the movement of moisture towards the outer surface. External hot air movement over the surface of the material can remove the moisture from the surface and influence the further mass transfer from the material. IR drying provides less drying time, is highly energy efficient, uniform in drying, and has good quality dried products. Infrared offers faster drying of products with minimum energy consumption and nutrient losses than conventional dryers. Also, IR heating provides high heat transfer with less drying time and energy cost. Drying using IR radiation will result in better quality products than another drying process since the heating is fast and uniform.

IR drying can be considered to be an artificial sun drying method and it can sustain throughout the day. Advantages of using IR for drying include flexibility of operation, simplicity of the required equipment, fast response of heating and drying, easy installation to any drying chamber, and low capital cost (Sandu, 1986). It can be used for various food materials like grains, flour, vegetables, pasta, meat, and fish. A simple IR dryer consists of an inlet and outlet hopper, manual conveyor system, IR lamp arrangements, voltage regulator, and timer relay. Food product enters from the inlet hopper to the manual conveyor and it moves parallel to the IR lamps and dried. The IR radiation intensity can be adjusted via the voltage regulator and intermittent IR drying can be implemented by a timer relay.

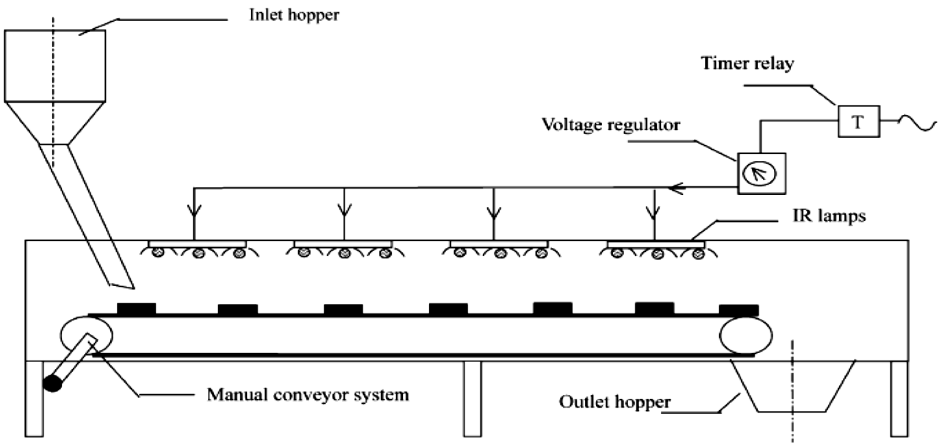

Fig. 1 Conveyor type IR drying system (Ratti and Mujumdar, 1995)

Drying of anchovy fish using IR dryer

IR drying of anchovy fish was carried out using the hot air-assisted continuous IR dryer (Fig. 2) with the IR intensities of 1,000, 2,000, and 3,000 W/m^2, IR source to sample distances of 5, 10, and 15 cm, drying temperature of 65°C, and air velocity of 1.5 m/s. Prior to the drying experiment, dryer was allowed to run for 30 min to achieve the set conditions. One kilogram of cleaned anchovy fish was filled in the feed hopper after reaching the required conditions. The hot air-assisted continuous IR dryer is having the input capacity of 0.2 kg/min for the continuous mode of operation. However, in case of anchovy fish drying the residence time of 1.5-3 h inside the dryer is essential to achieve the final moisture content of less than 15%. Hence, the conveyor belt was switched on for 8 min to spread the fish in the top layer of the dryer and switched off for 45 min to 1.5 h to ensure proper exposure of anchovy fish to IR radiation. This on/off time was obtained through prior experimental trials and the same operation was continued till the fish reaches the required moisture content. The drying chamber temperature was measured using a J-type thermocouple and product temperature was measured using a handheld IR thermometer with a precision of ±2°C. A hot wire anemometer with an accuracy of ±0.1 m/s was used to measure the air velocity. Total energy consumption during each drying experiment was measured using an energy meter in kWh (Make: Schneider, Model- Conzerv EM 1000). Drying was continued till the anchovy attains about less than 15 %wb moisture content. Because the moisture content of 15% or less retards the growth of mold and prolongs the shelf life. After the drying process, the dried anchovy fish were packed in laminated polyethylene polyesters, weighed, and then stored at room temperature (28 ± 2°C).

Fig. 2 Hot air-assisted continuous infrared dryer

The drying process of small and large size anchovy fish in a hot air-assisted continuous infrared dryer revealed the following results:

- The moisture content of small and large size anchovy fish was reduced to the final moisture content of 11.02 to 13.26 (%wb) in 3.5 h.
- Drying occurred in the falling rate period in all combinations of drying.
- The maximum drying efficiency of 46 % and 38.8% for small and large anchovy fish, respectively was observed at 2000 W/m^2 and 5 cm.
- The lowest SEC values in small and large anchovy fish were 1.36 and 1.61 kWh/kg, respectively at 2000 W/m^2 and 5 cm.
- IR intensity and distance between the IR source and the sample were significantly ($p<0.05$) influenced the drying and quality characteristics of anchovy fish.
- The lowest water activity, shrinkage, colour change and maximum rehydration ratio were observed at 2000 W/m^2, 10 cm and 2000 W/m^2, 5 cm for small and large anchovy fish, respectively.

Hence, it was concluded that hot air-assisted continuous IR drying is a promising method for anchovy fish drying and the hot air-assisted continuous IR dryer can be adopted for the production of dried small and large anchovy fish.

Drying of shrimp using IR dryer

Performance evaluation of continuous IR dryer (Fig. 2) was carried out by analyzing the drying characteristics of shrimp under three operating modes: hot air (HA), infrared radiation (IR) and combination of infrared radiation and hot air (IR-HA). Infrared power, drying air velocity, distance from infrared radiation source to sample and air temperature values were selected based on literature review and preliminary trials. Hot air (HA) drying was performed at 45°C and 1.5 m/s with infrared heaters in off condition. Infrared radiation (IR) mode of drying was conducted with the infrared power of 4500 W (Intensity is 3000 W/m^2), air velocity and temperature of 1.5 m/s and 28±2°C and infrared radiation source to sample distance of 10 cm. Combination of IR-HA drying was done at distance from infrared radiation source to sample of

10 cm, air temperature 45°C, infrared power of 4500 W and drying air velocity of 1.5 m/s. Dryer was allowed to run for 30 min before each experiment to achieve the set conditions.
For each drying experiment 4 kg of cleaned samples were taken and filled in feed hopper. The chamber temperature was measured using J-type thermocouple and shrimp temperature was measured using handheld infrared thermometer with an accuracy of ± 2°C. Relative humidity of air was ranged from 70±1% to 35±1% during drying. Hot wire anemometer with accuracy of ±0.1 m/s was used to measure the air velocity. Total energy consumption during each drying experiment was measured using energy meter in kWh (Make: Schneider, Model – Conzerv EM 1000). Drying was continued up to 10-15 %wb moisture content. Dried shrimps were packed in laminated polyethylene polyesters and stored at room temperature (28±2°C). The photograph of shrimp drying in the hot air-assisted continuous infrared dryer is presented in Fig. 3.

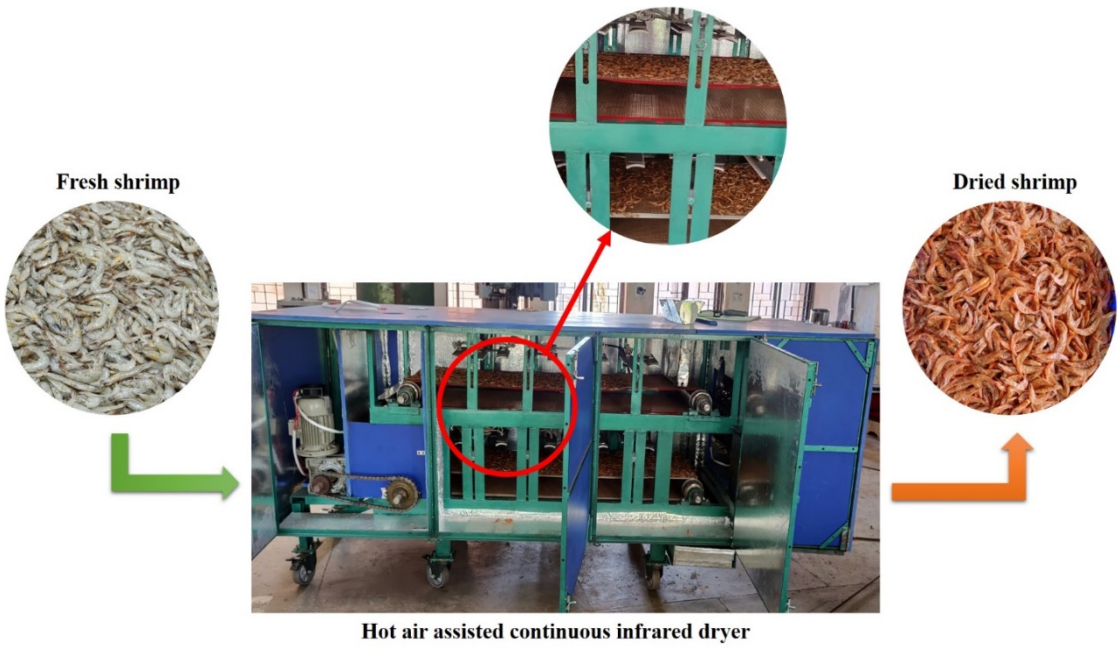

Fig. 3 Shrimp drying process in the hot air-assisted continuous infrared dryer

The hot air assisted continuous infrared dryer was found to be the most suitable dryer for shrimp drying in combined IR-HA mode of operation than HA and IR drying. The shrimp drying process occurred in the falling rate period in all the drying modes. Lowest drying time (2 h), specific energy consumption (1.80 kWh/kg of water evaporated), shrinkage (7.27%), water activity (0.57) and maximum drying efficiency (36.25%), sensory score (8.33) was observed in combined IR-HA drying. Overall, the drying of shrimp in IR-HA drying was quicker, consumed less energy and superior quality product in terms of physical, sensory characteristics and proximate composition. This dryer can be used for the production of high-quality dried shrimp with economical viability and it can be scaled up for commercial-scale continuous production. Similarly, other products like dried clam and squid rings, marinated and dried anchovy, shrimp, squid rings can also be prepared using this IR dryer.

Reference

Ratti, C., & Mujumdar, A. S. (1995). Infrared drying. In A. S. Mujumdar (Ed.), Handbook of industrial drying (pp. 567–588). New York: Marcel Dekker.

Sakai, N. and Hanzawa, T. 1994. Applications and advances in far infrared heating in Japan. Trends in Food Science & Technology. 5: 357–362.

Sandu, C. (1986). Infrared radiative drying in food engineering: a process analysis. Biotechnology Process, 2, 109–119.

****