ABSTRACT

The central theme of this study is the assessment and optimum utilization of heat resource and optimization of the cost of turmeric processing plant.

Turmeric is the dried Rhizome of the plant Curcuma domestica var. syn. C. Longa L. Turmeric is used in mustard paste, curry powder, brine pickles, relish formulations, in breading of frozen fish sticks, butter, cheese, ice-creams, soap, vegetable and meat dishes. In foods, the antioxidant property of turmeric was effective in preventing peroxide development. Turmeric powder mixed with sesame, coconut or groundnut oil is used for pickling mango, lemon, garlic etc. Turmeric is credited with medicinal properties as anti-inflammatory, anti-microbial, anti-rheumatic, hypersensitive, antibacterial, antiviral, anti-diabetic and anti-hepotoxic. Due to these medicinal properties, turmeric is used in digestive disorders, hyperacidity, blood purifier, used for cuts, burns, anti-inflammatory effects. It is also used in cosmetics to glow the skin etc. India ranks first in production of turmeric i.e. 701.16 Lac tones from 185.32 Lac hectare of area. Maharashtra produces about 400 MT from 700 hectare area. There are about sixty cultivars available in the country. The famous varieties are Rajapuri, Prabha, Saguna, Sudarsana, Krishna, Selem, Barshi, Suvama etc. There are six taxonomic varieties within C. Longa based on numerical taxonomic analysis.

Turmeric can be processed in the various steps as: Separating Rhizomes from plant, washing, boiling/blanching, drying, coloring, powdering packing and marketing. The primary processing of turmeric is done with traditional method with one or other changes made in it throughout the country. In traditional method shallow open mild steel pan is used for boiling turmeric Rhizomes. The pan is kept on the furnace and turmeric Rhizomes are heaped in, water is added upto ¾ th part of the heap height in pan and covered by gunny bags or plastered. It takes about 50-60 minutes to boil the water and 40-45 minutes to boil the turmeric. The boiled Rhizomes are then pulled out of the pan with the help of wooden comb with long handle and allowed to leach the water through it. The boiled Rhizomes are spread on a clean open ground for drying.
The conventional method has many drawbacks such as: there is loss of heat and loss of time. The quality and quantity of the Rhizomes are affected due to mud mixing, scorching and trampling, during loading and unloading the Rhizomes. Mixing of cowdung, ammonia, sodium carbonate is hazardous to health, the overall processing cost of turmeric Rhizomes increases due to labor cost, drying method, heat losses, quality and quantity losses.

In the literature review, there is thermostructural analysis of various components, design of various pressure vessels, design of heat and steam carrying devices is focused. Researchers have utilized the various softwares like ANSYS, Uni-Graphics, Solid Edge and other softwares for designing various heat and steam carrying devices and pressure vessels. Today it is required to focus on the Agricultural equipments and their software design so that they can be manufactured in economical cost. It is found that the researchers have not focused on the design of turmeric processing unit. The main problems in processing of turmeric were studied and taken into consideration through literature review. The field problems in the processing method were discussed with the experts and leading farmers in the exhibition held at Marathawada Agricultural University, Parbhani.

Considering the field problems and conclusions from the literature review the research work is undertaken to design and fabricate a turmeric processing unit called blancher. It is designed by conventional method and modelled in Uni-Graphics software. A high quality SS 304 L stainless steel is chosen for fabrication. A mathematical model is developed to calculate steam flow rate and time required to process the turmeric Rhizomes. Based on process requirement, the blancher is designed to handle 50 kg of turmeric in single batch. The designed model is exported to hypermesh software for meshing the model and then it is exported to ANSYS software for thermal and structural analysis. The finite element model is generated with the quadrilateral, 2D shell and 3D brick elements to generate mesh. The self weight is considered 1 G [9.81 m/s² and 760 Torr], number of 2D elements are 72391 and number of 3D elements are 18289 and total number of elements are 90680. The thermal analysis is carried out within temperature limits 120°C to 210°C and pressure limits 2 bar to 9 bar using
ANSYS software. The results indicate that there is uniform temperature and heat distribution throughout the assembly. The results of deflection and stress analysis shows that the deflection is less at pressure 3 bar and it increases with increase in pressure up to 9 bar. The values of deflection and stresses are increasing gradually with increase in pressure but their values are within the safe limits. Since the actual value of steam pressure is not more than 2 bar, hence the design is safe.

An experimental work is carried out by fabricating a prototype of the blancher. A 50 kg capacity blancher is fabricated with certain modifications according to availability of material with standard dimensions. The test is carried out for 15 minute, 20 minutes and 25 minutes respectively. The better results were found when the Rhizomes were heated between 15 to 20 minutes. The quality parameter curcumin 4.27 % and oleoresin 5.04 % is better than traditional method and the Rhizomes are softer and easy for polishing. The proposed blancher method of turmeric processing reduces fuel consumption from 87.5 kg to 20 kg per 100 kg batch. The time consumption and labor cost is reduced to 50 %. The quantity and quality of the Rhizomes are increased to 7 to 8 % due to steam boiling, due to reduction in loss of volatile matter and reduction in loss of quality and quantity in traditional handling. The thermal efficiency of traditional method is 3.95 % where as by proposed blancher method it is 12.2 %. Hence it is proposed to use mobile blancher for turmeric processing in future.

Keywords: Design of blancher, Uni-Graphics™ software, Thermosturcutral analysis, ANSYS™ software, fabrication and testing.