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Research Paper

Comparative study on drying practices of flours and spices

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ABSTRACT : The major share of the loss occurs during storage of surplus stock. Among the various causes of losses, the most important one is improper drying before storage. So, present study was conducted to compare the existing flours and spices drying practices with solar bed technology on the basis of temperature, moisture and infestation. In study it was found that in village most common practice of drying was found to be drying of food commodities on cloth. The temperature in solar bed was higher up to 75.66±2.30 and significantly higher and differed to direct storage and open exposure temperatre (CD = 4.88), moisture was also different in direct storage (2.34^a±0.47), open storage(1.89^a±0.67) and solar bed storage (1.02^b±0.23) with CD value of 0.22 in case of semolina. No infestation was also found in solar bed drying practices. Other side in comparison, was done on open exposure and solar bed drying on the basis of temperature and time in killing insects, found that temperature was higher in solar bed drying and time in killing insect was less. It is concluded that more the thickness of two polythene sheets (black and transparent) higher the temperature in solar bed and hence less is the time of killing of insects in spices and flours.

KEY WORDS : Moisture, Infestation, Open storage, Solar bed

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In India, every year nearly 10 per cent of the food grains are lost during post-harvest processing and storage due to insect infestation. Increased production would hardly have any significance unless protected from post harvest loss. A recent estimate by the Ministry of Food and Civil supplies put the total preventable post-harvest losses of food grains due to insect infestation at about 20 million tons per year, which was nearly 10 per cent of the total production that could have fed up to 117 million people for a year. Insect pest activity in agricultural produce may start at any stage from harvest to consumption. Insect infestation causes qualitative and quantitative losses of food commodities and changes the chemical composition affecting the nutritive value of the produce.

Drying is the most common and fundamental method for post-harvest preservation of food commodities because it allows for the quick conservation of the food qualities of the plant material in an uncomplicated manner. Since agriculture is the main preoccupation of rural dwellers who account for over 80 per cent of the population, and since foodstuffs need to be conserved at the farm level, drying is considered an important factor in achieving food security in many countries. However, due to certain inadequacies of traditional drying, there are besides the losses in weight of agricultural products, losses in their quality, due to health hazards such as aflatoxins. Losses in the nutritional quality of dried products are another important consideration in traditional drying. The major share of the loss occurs during storage of surplus stock. Among the various causes of losses, the most important one is improper drying before storage (Patil, 2002). To promote the use of dryers in rural areas, Ojha (1984) put the concept of a community drying-cum-storage system forward in 1984.

India is blessed with around 300 sunny days around the year. Drying in the sun is inherently widespread and cheap. Open sun drying is unhygienic, unreliable and time consuming. Solar bed dryer can be considered as an elaboration of sun drying and is an efficient system of utilizing solar energy. (Padmaja, 1999). Based on the data available with the Indian Meteorological Department, the average solar radiation for India is about 420 cal/cm2 per day The total energy received in India is estimated to be 60 x

10(16) kwh/year (Bhide, 1995). The heat available therefore, assuming a 12 hour day, is 21.6 MJ/m², a quantity theoretically sufficient to evaporate 9 kg of water. Direct sunlight destroys some of the more fragile vitamins and enzymes and the food loses colour. So, the solar bed technology is tested for safe drying and storage practices of spices and flours. In view of this, the present work was aimed at the development of a low cost solar bed technology for safe storage of spices and flours.

■ RESEARCH METHODS

The present study was conducted to find out the best way of drying of flours and spices. Study was undertaken in two phases.

Phase 1:

Two existing drying practices (direct storage and storage after open exposure) were taken after studying the village drying practices and which were mostly taken by respondents to dry the flours and spices. Besides these, solar beds technology was taken to find out the best drying practices on the basis of temperature, moisture (before and after storage) and infestation. Nine samples of ½ kg of each spice (turmeric, red chilli, coriander) and flours (semolina, gram flour and refined flour) were taken for 3 treatments. Each treatment was replicated thrice.

Treatment-1 (Direct storage) :

In first treatment, ½ kg of each spices and flours were stored in plastic container for fix time period (30 days, 60 days, 90 days) after direct purchase.

Treatment-2 (Stored after open sun exposure) :

In second treatment, ½ kg of each spice and flour spread on cloth was exposed to sun for half an hour (12:00 to 12.30 pm) and then stored in plastic container.

Treatment-3 (Stored after exposure in solar bed) :

In third treatment, ½ kg of each spice and flour spread in solar bed was exposed to sun for half an hour (12:00 to 12.30 pm) and then stored in plastic container.

Moisture of each sample was recorded before storage and after exposure to sun for 30 min(open exposure and solar bed exposure). Temperature recording was started at 12:00 noon and continued at 5 minute intervals until 12:30 pm.

Phase II:

In second phase the comparison was done on open exposure drying and solar bed drying on the basis of thickness of polythene and time of killing of insect.

Modification of solar bed :

To modify the solar bed, different thicknesses of polythene sheets were used for conducting experiments. The experiments were conducted on two bases:

Thickness of polythene:

Three different type of thickness (55 mu, 85 mu and 115 mu) of polythene sheet (black and transparent) was used for conducting experiments.

Exposure time in killing insects:

Solar bed with different thickness of polythene was used for conducting experiments. Infested spices and flours with 100 *Tribolium castaneum* (flour beetle) were taken for the experiments. Average ambient temperature as well as inside temperature of solar bed was recorded. Temperature recording started at 12:00 noon and continued at 5 minute intervals until 12:30 pm. Time and temperature were also noted at the time of killing of insects in three different solar beds.

Statistical analysis :

Data coding, entry and validation were done using appropriate software mainly SPSS/PC and't'-test were used for analyzing the data. Frequency and percentages were also calculated.

■ RESEARCH FINDINGS AND DISCUSSION

The results of the present study as well as relevant discussions have been presented under following sub heads:

Existing practices used for exposure of spices and flours:

Table 1 shows the existing practices of sun exposure of spices and flours. Results showed that majority of the respondents (44.45 %) used cloth for exposure of turmeric, followed by 33.33 per cent who gave exposure to turmeric on plate/thali and 22.22 per cent used plastic sack for exposure.

In red chilli 36.84 per cent respondents gave exposure

Table 1: Existing practices used for exposure of spices and flours

Spices and flours	n	On cloth	On plastic sack	On newspaper	On metal plate/ *thali*
Turmeric	9	4 (44.45)	2 (22.22)	---	3 (33.33)
Red chilli	38	14 (36.84)	10 (26.32)	7 (18.42)	7 (18.42)
Coriander	4	3 (75.0)	__	__	1 (25.0)
Gram flour	27	13 (48.15)	7 (25.93)	2 (7.14)	5 (18.52)

Values are mean ±SD

on cloth, followed by 26.32 per cent on plastic sack and equal percentage (18.42%) of the respondents used newspaper and metal plate/ *Thali* for exposure of red chilli. In case of coriander, majority of the respondents (75%) used cloth for sun exposure and 25 per cent respondents used metal plate/ *Thali*. Near about 50 per cent respondents used cloth for exposure of gram flour, followed by 25.93 per cent who used plastic sack, 18.52 per cent used metal plate/*Thali* and 7.14 per cent used newspaper for exposure of gram flour. Because majority of the respondents were using cloth for drying of spices and flours, so for further study cloth was taken as existing drying practices.

Comparison of direct storage, open exposure and solar bed storage on the basis of infestation :

To find out the best practices of drying three different practices were tasted on the basis of temperature, moisture and infestation. Mean differences in direct storage, open exposure and solar bed on the basis of temperature, moisture (before and after storage) and infestation have been presented in Table 2. Data show that the temperature in direct storage, open exposure and solar bed of each spice (turmeric, red chilli, coriander) and flour (semolina, refined flour and gram flour) significantly differed to each other. The moisture content in direct storage, open exposure and solar bed before storage of refined flour, coriander and turmeric was significantly different to each other. The moisture content in red chilli before storage in solar bed (X=1.02±0.23) was significantly lower in comparison to open exposure (X=1.89±0.67) and direct storage (X=2.34±0.47). On the other side, the moisture content of semolina and gram flour in direct storage (X=9.22±0.67 and X=9.33±0.35) was significantly higher than open exposure (X=8.12±0.67 and X=7.99±0.89) and solar bed (X=8.00±0.15 and

Table 2 : Comparison of direct storage, open exposure and solar bed on the basis of infestation

Independent variables	Direct storage	Open exposure	Solar bed	CD
Temperature (^{0}C)				
Turmeric	34.33±0.67	43.33±0.33	69.58±0.74	2.49
Red chilli	37.00±1.03	44.66±0.57	72.66±1.03	4.68
Coriander	38.33±0.76	49.33±0.47	75.66±2.30	4.88
Semolina	32.66±0.23	41.66±1.15	70.00±0.98	2.25
Refined flour	34.00^a±0.57	44.00^b±1.30	73.66^c±1.15	2.22
Gram flour	36.33±0.50	45.33±0.57	74.33±1.03	2.29
Moisture before storage (%)				
Turmeric	9.33^a±0.33	6.89^b±0.55	6.00^c±0.55	0.33
Red chilli	2.34^a±0.47	1.89^a±0.67	1.02^b±0.23	0.22
Coriander	6.67^a±0.67	5.32^b±.15	3.89^c±0.33	0.39
Semolina	9.22^b±0.67	8.12^a±0.67	8.00^a±0.15	0.54
Refined flour	9.22^a±0.55	8.34^b±0.04	7.00^c±0.10	0.78
Gram flour	9.33^b±0.35	7.99^a±0.89	7.22^a±0.33	1.54
Moisture after storage (%)				
Turmeric	10.77^a±0.33	10.10^a±0.10	9.03^b±0.10	0.49
Red chilli	3.63^a±0.10	3.55^a±0.33	2.41^b±0.67	0.60
Coriander	8.12^a±0.55	6.15^b±0.15	6.08^b±0.15	0.64
Semolina	11.14^a±0.54	9.97^b±0.33	9.08^c±0.67	0.58
Refined flour	12.27^a±0.33	11.41^a±0.15	8.32^b±0.73	1.47
Gram flour	11.48^a±0.73	10.96^a±0.55	8.90^b±0.55	0.91
Infestation (No.)				
Turmeric	0.91^a	0.33^{ba}	0.00^b	0.67
Red chilli	3.50^a	1.75^{ba}	0.00^b	2.22
Coriander	48.00^a	26.58^a	0.00^b	23.08
Semolina	56.33	22.41	0.00	18.15
Refined flour	199.33	117.00	0.00	73.55
Gram flour	20.08	9.50	0.00	8.55

CD= Critical Difference

X=7.22±0.33).

Data further revealed that moisture content of turmeric and red chilli after storage in solar bed (X=9.03±0.10 and X=2.41±0.67) was significantly lower than open exposure (X=10.10±0.10 and X=3.55±0.33) and direct storage (X=10.77±0.33 and X=3.63±0.10). Moisture content of refined flour and gram flour in solar bed (X=8.32±0.73 and X=8.90±0.55) was significantly lower in comparison to open exposure (X=11.41±0.15 and X=10.96±0.55) and direct storage (X=12.27±0.33 and X=11.48±0.73). In coriander, moisture content in direct storage was significantly higher (X=8.12[a]±0.55) than open exposure (X=6.15±0.15) and solar bed (X=6.08±0.15). In semolina, the moisture content in direct storage (X=11.14±0.73), open exposure (X=9. 97±0.33) and solar bed (X=9.08±0.67) was significantly different to each other.

Exposure time in killing of all insects in spices and flours in open exposure and solar bed :

After making the test on three different drying practices, two drying practices (open exposure and solar bed drying) were taken for further study. Results in Table 3 show that open exposure took more time period to kill insects due to low temperature, while solar bed took less time period to kill insects due to higher temperature. Infestation of turmeric *(Rhizomes)* were killed in 5.67 min at 60.00±1.03 ^{0}C, followed by open exposure which took 14.33 min at 43.67±0.57^{0}C to kill same number of insects. In red chilli and coriander, open exposure also took more time period (16.78 min and 15.33 min) in comparison to solar bed (7.33 min and 7.67 min).

In flours open exposure took more time period (13.33, 13.33 and 15.67 min) at 44.22±0.10^{0}C, 45.67±0.36^{0}C and 46.33±0.57^{0}C, while solar bed took small time period (4.58, 5.67 and 5.08 min) at 61.58±0.35^{0}C, 60.00± 0.10^{0}C and 61.58±0.23^{0}C, respectively.

Correlation between infestation in spices and flours on the basis of temperature and moisture :

Scrutiny of Fig. 1 revealed that infestation in each spice (turmeric, red chilli and coriander) and flour (semolina, refined flour and gram flour) was highly significantly and negatively correlated to temperature (r=-0.40**, r=-0.51**, r=-0.57**, r=-0.68**, r=-0.67** and r=-0.54**, respectively). Data further revealed that infestation in turmeric and red chilli was significantly and positively correlated to moisture content (r=0.69* and r=0.71*) and infestation of coriander, semolina, refined flour and gram flour was highly significantly and positively correlated to the moisture content (r=0.71**, r=0.68**, r=0.94** and r=0.64**).

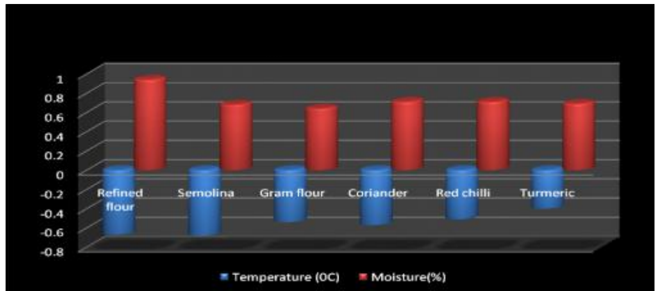

Fig. 1 : Correlation between infestation in spices and flours on the basis of temperature and moisture

Modification of solar bed :

Exposure time in killing insects by using different gauge of solar bed sheets :

Data compiled in Fig. 2 unveiled that temperature in case of polythene with more gauge was raised to higher degree and killed the insects in shorter time period in comparison to less polythene gauge. Results showed that temperature in solar bed with polythene of higher gauge

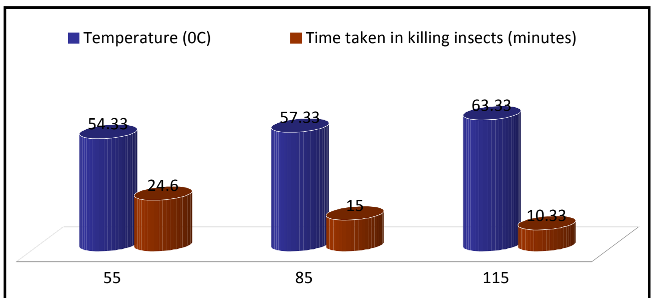

Fig. 2 : Exposure time in killing insects by using different gauge (mu) of solar bed sheets

Table 3 : Exposure time in killing of all insects in spices and flours in open exposure and solar bed

Spices and flours	Infestation and species (no.)	Temperature at the time of killing insects (^{0}C)		Time taken in killing insects (in minutes)	
		Open exposure	Solar bed	Open exposure	Solar bed
Turmeric	2 *Rhizomes*	43.67±0.57	60.00±1.03	14.33	5.67
Red chilli	20*Lasioderma*	44.33±0.23	62.67±0.87	16.78	7.33
Coriander	20*Lasioderma*	45. 67±0.76	62.33±0.33	15.33	7.67
Semolina	20 *Tribolium*	44.22±0.10	61.58±0.35	13.33	4.58
Refined flour	20 *Tribolium*	45.67±0.36	60.00±0.10	13.33	5.67
Gram flour	20 *Tribolium*	46.33±0.57	61.58±0.23	15.67	5.08

(115mu) was raised to high degree (X=63.33±0.23) in comparison to 85mu gauge (X=57.33±0.10) and 55 mu gauge (X=54.33±0.78) and took shorter time period to kill insects (10.33 min) in comparison to 85 mu gauge (15.0 min) and 55mu gauge (24.6 min).

For the past two decades, India has the know-how and technology to produce high-yielding crops and, especially in fertile states such as Karnataka and this technology has been rather successful. However, the problem in India, where 60 per cent of the economy is dependent on agriculture, is the inability to preserve agricultural surpluses. According to a 1999 World Bank Report, post-harvest losses amount to 12 to 16 million metric tons of food grains each year - an amount that the World Bank stipulates could feed one-third of India's poor.

Results from the study showed that temperature of solar bed was higher in all spices and flours as compared to open exposure and direct storage. Bukola (2008) revealed that the temperatures inside the dryer and solar collector were much higher than the ambient temperature during most hours of the day-light. The temperature rise inside the drying cabinet was up to 74 per cent for about three hours immediately after 12.00 noon. In refined flour temperature at 12:00 noon in solar bed was significantly higher as compared to open exposure and direct storage. The moisture content in different time periods showed that moisture content in each spice and flour was lower in solar bed in comparison to direct storage and open exposure. Similar result was found by Grover in 2008 who reported that in 3 months of gram storage, the moisture content in solar bed was significantly lower (9.1%) in comparison to open exposure (12.4%) and direct storage (13.6%).

In the present study, no infestation occurred in spices and flours which were stored after solar bed exposure. Similarly Baiyeri (2004) reported that sun-drying of food removes water, reduces moisture content and concentrates nutrients. It is concluded that more the thickness of two polythene sheets (black and transparent) higher the temperature in solar bed and hence less is the time of killing of insects in spices and flours. The experiments were also conducted with different size of polythene sheets *i.e.* 1x1m, 1x1 ½ m and 1x2m but it was found that there was no change in moisture content, temperature and time taken in killing insects because there was only ½ kg of each spice and flour and these were spread in single layer in all the three sizes of polythene sheets. Thus, the solar bed with polythene sheets of more thickness was found to be the best because due to the increased thickness of black polythene sheet, the heat absorbed was more since black colour is a good absorber of heat and hence the exposure time in which the insects were killed was found to be minimum.

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