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Effect of temperature and relative humidity on variation of physico-chemical properties of storage and packed jaggery

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Short term storage of jaggery by different methods under laboratory conditions indicated that the jaggery stored in air tight container for 90 days maintained its quality and colour closely followed by wrapping with alkathene film and packed in paper box covered by polythene pouch as compared to jaggery kept open as it is without covering wrapped with gunny and Hessian cloth or packed with sugarcane trash and stored.

Key Words : Jaggery, Storage, Package, Temperature, Relative humidity

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INTRODUCTION

Production of jaggery is a vast cottage industry and also known as health friendly sweetener among rural masses since immemorial times. in India, the traditional methods of jaggery storage prevalent in western and eastern regions like open storage, matka, gunny bags etc.

These methods don't work in some regions because climatic conditions are not favourable for keeping quality of jaggery as there is very high humidity in these areas. During mansoon period, due to high humidity range, jaggery samples get infected with microbial activity and thus keeping quality of jaggery goes down. Jaggery samples could be stored in cold storage but sometimes it is difficult to store the samples for small scale farmers as cost involved is the main constraint for that. Also the energy consumption is very high. Jaggery from cold storage is used in off-season at high cost.

Mandal *et al*. (2006) studied the effect of common packing materials on keeping quality of sugarcane Jaggary during monsoon season. In their studies, it was revealed that the best packing material for storing Gur during monsoon season was heat sealed LDPE (Low Density Polyethylene) packet of 150 gauge followed by glass jars. LDPE packets prevented moisture ingress, fall in pH and inversion of sucrose in the stored Gur to the maximum extent. However, colour of Gur in LDPE packets was darker as compared to Gur stored in glass jars. PET (Poly Ethylene Terephthalate) jars were as good as glass jars but the stored Gur darkened more in PET jars. Canisters were better in comparison to painted earthen pots provided those were with airtight lid. Physical deterioration includes impairment of colour such as darkening, loss of texture and change in taste caused by bio chemical disintegration of some of jaggery constituents and weight loss due to desiccation. Chemical deterioration is brought about by bio-chemical changes in the jaggery composition particularly those responsible for inversion of sucrose and discoloration and eventually results in injury to one or

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more of the chief physical characteristics of jaggery colour, body and taste.

Damage from insects and ants in particular, is the most series and important form of biological spoilage of jaggery. Fermentation brought about by yeasts and complex of biochemical degradation caused by moulds are the usual forms of microbial spoilage.

Jaggery when produced is practically free from microbes. It however, gets contaminated during handling and storage. Depending upon the moisture content of jaggery, microbes convert complex sugars into simpler ones, which make the jaggery more hygroscopic.

Dakshindas and Kale (1961) studied the effect of various storage methods. Their observations indicates that rate of absorption of moisture was more rapid in the case of samples coverd with gunny cloth than those preserved in rice husk probably, due to porousness of the gunny cloth. Further, their study indicated that the jaggery blocks when kept in well ventilated godowns on wooden stands or palm matting and arranged in a rows of 3-4 black height, proved better in maintaining the quality.

METHODOLOGY

The laboratory experiments were conducted at the college of agriculture, V.C. Farm, Manya, Karnataka. The fresh jaggery cubes made from matured sugarcane were procured from local jaggery industry and subjected to physico-chemical propertities before storing by adopting standard techniques and procedures. The jaggery was stored in seven different preservation methods under laboratory conditions. The preservation methods are stored of jaggery

T_1: Cubes as it is in open as control.

T_2: Cubes packed with sugarcane trash and stored.

T_3: Cubes wrapped with gunny cloth and stored.

T_4: Cubes wrapped with Hessian cloth and stored.

T_5: Cubes wrapped with alkathene film and stored.

T_6: Cubes packed in paper box covered by polythene pouch and stored.

T_7: Cubes stored in airtight container and stored.

The samples drawn at every 15 days intervals in each treatment and were subjected to physico-chemical properties by adopting standard techniques and procedures such as the moisture content, sucrose, porosity dirt and impurities (Mandal *et al.*, 2006) and ash content. The ambient temperature and the relative humidity (RH) under laboratory was varying between 24 to 27^0C and 73 to 81 per cent, respectively during storage period. The data was analyzed statistically and presented in Table 1 and Fig. 1 to 8. The reducing sugars was estimated by titrating the jaggery solution (10g) dissolved in 100 ml water and clarified with lead sub acetate with 10 ml of Fehlings (A+B) solution according to Lane and Eynon Volumetric methods

$$\text{Reducing sugars per cent} \frac{\text{0.05 x Volume of jaggery solution}}{\text{T.V. x Wt. of Jaggery}} \text{ x 100}$$

where, T.V. is the titrate value

OBSERVATIONS AND ASSESSMENT

The results obtained from the present investigation as well as relevant discussion have been summarized under Table 1 and Fig. 1 to 8.

Temperature and relative humidity :

Sastry *et al*. (1964) studied effect of different temperature and relative humidity on the keeping quality of gur. The study reveals that the gur kept at 43 per cent relative humidity at room temperature or 53 per cent relative humidity at low temperature tended to loss moisture. At 71 per cent relative humidity and above, the

Table 1 : Effect of temperature and relative on colour and texture of jaggery during storage

Storage period	T_1		T_2		T_3		T_4		T_5		T_6		T_7	
	C	T	C	T	C	T	C	T	C	T	C	T	C	T
0-DAS	G.Y	A.M	G.Y	A.M	G.Y	A.M	G.Y	A.M	G.Y	A.M	G.Y	A.M	G.Y	A.M
15	L.Y	A.M	G.Y	A.M	G.Y	A.M	G.Y	A.M	G.Y	A.M	G.Y	A.M	G.Y	A.M
30	L.Y	A.M	G.Y	A.M	G.Y	A.M	G.Y	A.M	G.Y	A.M	G.Y	A.M	G.Y	A.M
45	L.Y	A.M	G.Y	A.M	L.Y	A.M	G.Y	A.M	L.B	A.M	G.Y	A.M	G.Y	A.M
60	L.B	A.M	G.Y	A.M	L.Y	A.M	G.Y	A.M	L.B	A.M	L.B	M.A	L.B	M.A
75	D.B	H.A	L.B	H.A	L.B	A.M	L.B	M.A	L.B	H.A	L.B	M.A	L.B	M.A
90	D.B	V.H	L.B	H.A	L.B	M.A	L.B	M.A	L.B	H.A	L.B	M.A	L.B	M.A

G.Y—Golden yellow, L.Y—Light yellow, H.A--- Hard and amorphous, M.A-Medium amorphous, N.C---No change, L.B---Light brown, D.B---Dark brown, A.M---Amorphous, V.H---Very hard Amorphous, T-Texture, C-Colour.

gur gained moisture in a faster rate at room temperature than low temperature. Deterioration in colour at low temperature was neglizable while at room temperature it was considerable at relative humidity above 71 per cent. As far as changes in sucrose and reducing sugar are concerned, it was very neglizable at low temperature and tendency to increase at room temperature. They concluded that the optimum relative humidity for preservation of gur lies between 43 and 71 per cent and at room temperature and 53-81 per cent at low temperature.

The optimum relative humidity for storage of jaggery in trade center is found to be between 40-45 per cent (Gunjal and Galakatu, 1986).

Storage :

Rao and Lakshminarayan (1999) reported that jaggery has poor shelf life due to its inherent moisture content and suggested that jaggery can be made any shape and size yielding higher surface area per unit weight with minimum drying thickness for effective drying and storage in moisture impermeable bags. They also reported that, small sized cubes packed in moisture barrier packaging material can withstand at least one season compared to normal jaggery. Brick shaped jaggery was found to be more suitable for storage (Verma *et al*., 1999).

Jaggery samples stored in polythene and airtight glass jar for 6-months were found better (Pandey and Kulshreshta, 1999). When the jaggeries stored in earthen pots, hessian sacks and also open room, liquefied at higher Relative Humidity especially in monsoon season (Singh, 1999 b)

Uppal and Sharma (1999) stated that storing of jaggery dried at ambient temperature for 75 days, till its moisture content reached 3.5 per cent followed by its transfer to tightly closed glass container and kept at low temperature was the best method for preservation of jaggery to retain its good quality, colour appearance and complete check in microbial growth for more than a year.

Packing :

For better marketing and to fetch higher price it is important to maintain a uniform colour, shape and size of jaggery. Hygienically manufactured cubes packed in butter and glazed papers with cellophane wrapping attract consumers and fetch good price (Thakur, 1999).

Babu and Anwar (1995) reported that uniform bricks of jaggery packed in double layered butter and glazed paper with cellophane wrapping kept away the flies, dust and also attracted the consumer and fetched good price.

Moisture:

The safe limit of moisture content for better keeping quality of jaggery is 5 per cent and below. Over and above 5 per cent moisture content the micro organisms becomes active leading to quick deterioration of jaggery. The data presented in Fig.1 indicates that the jaggery samples were stored at 12 per cent moisture content and gradually decreased to about 5 per cent at the end of 90 DAS. It was less than 5 per cent at the end 90 DAS in treatments $T_{5,}T_6$ and $T_7$where the jaggery was wrapped with alkathne film, packed in paper box covered by polythene pouch and stored in air tight container, respectively as compare to rest of the treatments. This methods of packing and storing of jaggery prevented direct contact of jaggery with atmospheric moisture content (> 5 %) in the treatments where jaggery packed with sugarcane trash (T_2), wrapped with gunny cloth (T_3), wrapped with Hessian cloth (T_4) and stored may be due to the porous ness of the packing materials used might have allowed the absorption of surrounding moisture content.

Sucrose:

Sucrose in an important component in the jaggery to improve the keeping quality and to fetch higher market price. The jaggery containing 65 per cent and above sucrose is considered as good quality for human consumption The data in Fig. 2 indicates that the sucrose content in the jaggery samples at the time of storage was 84.43 per cent and it was gradually decreased to 60-65 per cent at the end of 90 days. It is clear from the data that the jaggery stored in airtight container maintained 65 per cent sucrose at the end of 90 DAS closely followed in jaggery packed with paper box covered by polythene pouches than compared to the other treatments.

Reducing sugars:

The presence of high amount of reducing sugars in jaggery contributes high hygroscopic nature of product. For better shelf-life, attractive colour and marketing, the jaggery should not contain more than 10 per cent reducing sugars. The data in Fig. 3 shows that data the time of storage jaggery containing 10 per cent reducing sugars, which was with in the safe limit of 10 per cent. As the

duration of storage increased the content of reducing sugars in the stored jaggery Increased gradually from 10 to 24.5 per cent. The per cent increase in reducing sugars was found to be comparatively less when the jaggery stored in airtight container as compared to the rest of the treatments. The observations made in this study are in conformity with

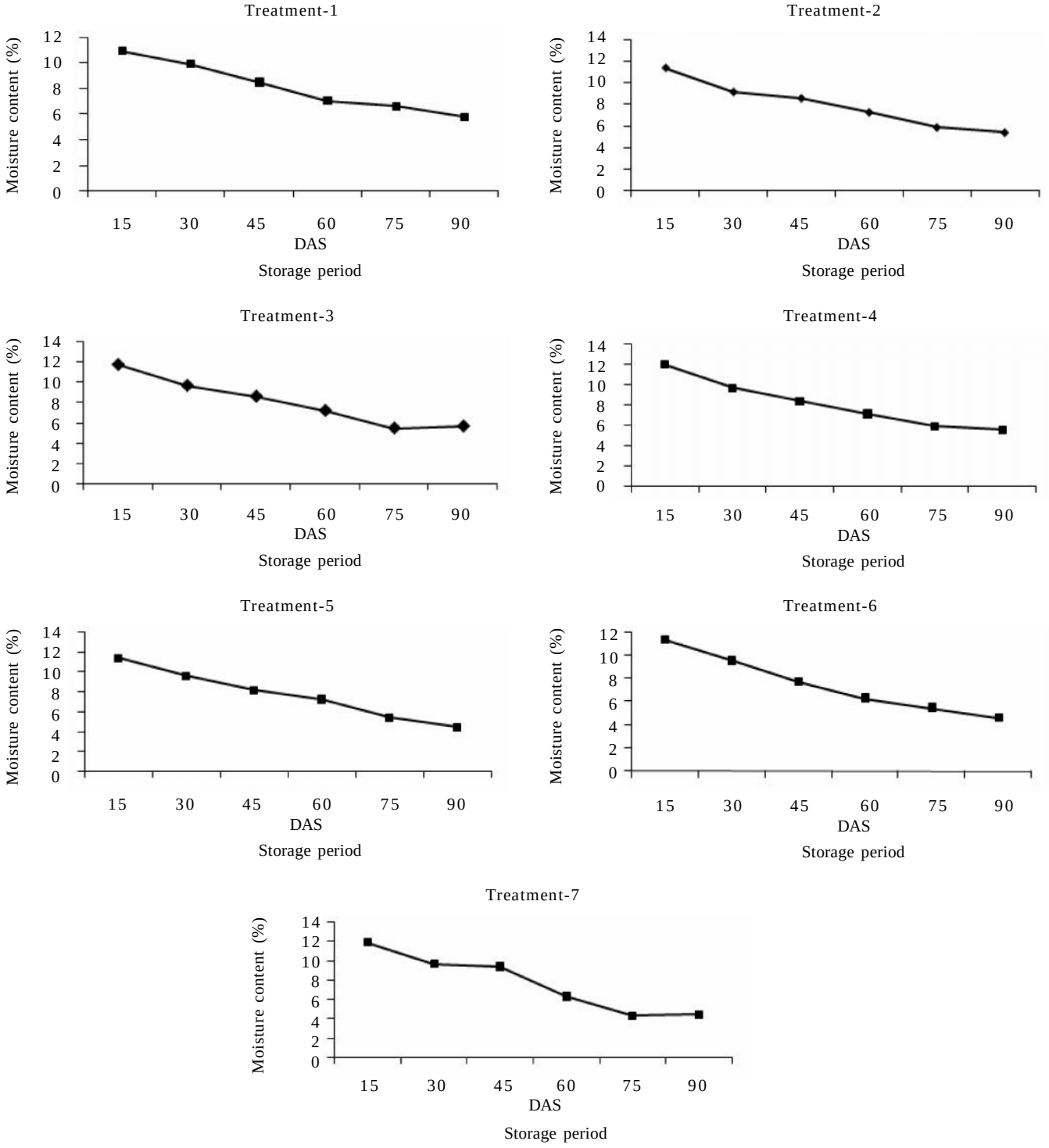

Fig. 1 : Effect of temperature and relative humidity on variation of moisture content during storage

the observations made by Singh (1999 a).

Porosity:

Porosity in jaggery is considered as one of the important properties and the method of moulding jaggery after kneading process has an important bearing on the porosity of jaggery. The amount of air space present inside the jaggery mould gives an indication about the crystalline

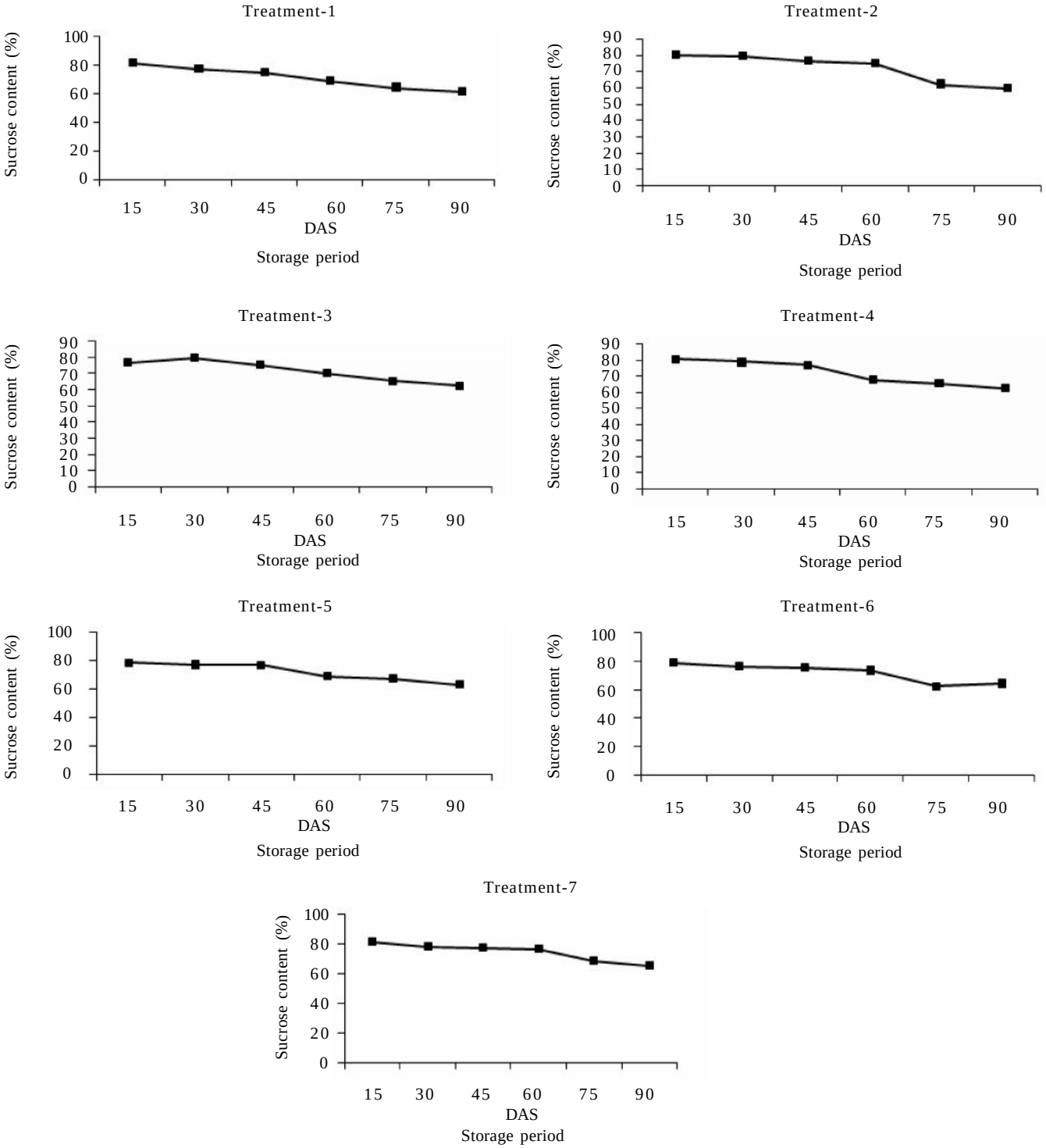

Fig. 2 : Effect of temperature and relative humidity on variation of sucrose content during storage

structure and keeping quality .The data in Fig. 4 reveals that the duration of storage increased the amount of air space present inside the cubes of jaggery reduced gradually. Further the data show that the per cent porosity in the stored jaggery was comparatively more in the jaggery stored in air tight container at the end of 90 DAS, closely followed in the treatments when the jaggery wrapped with alkathene film and packed in paper box

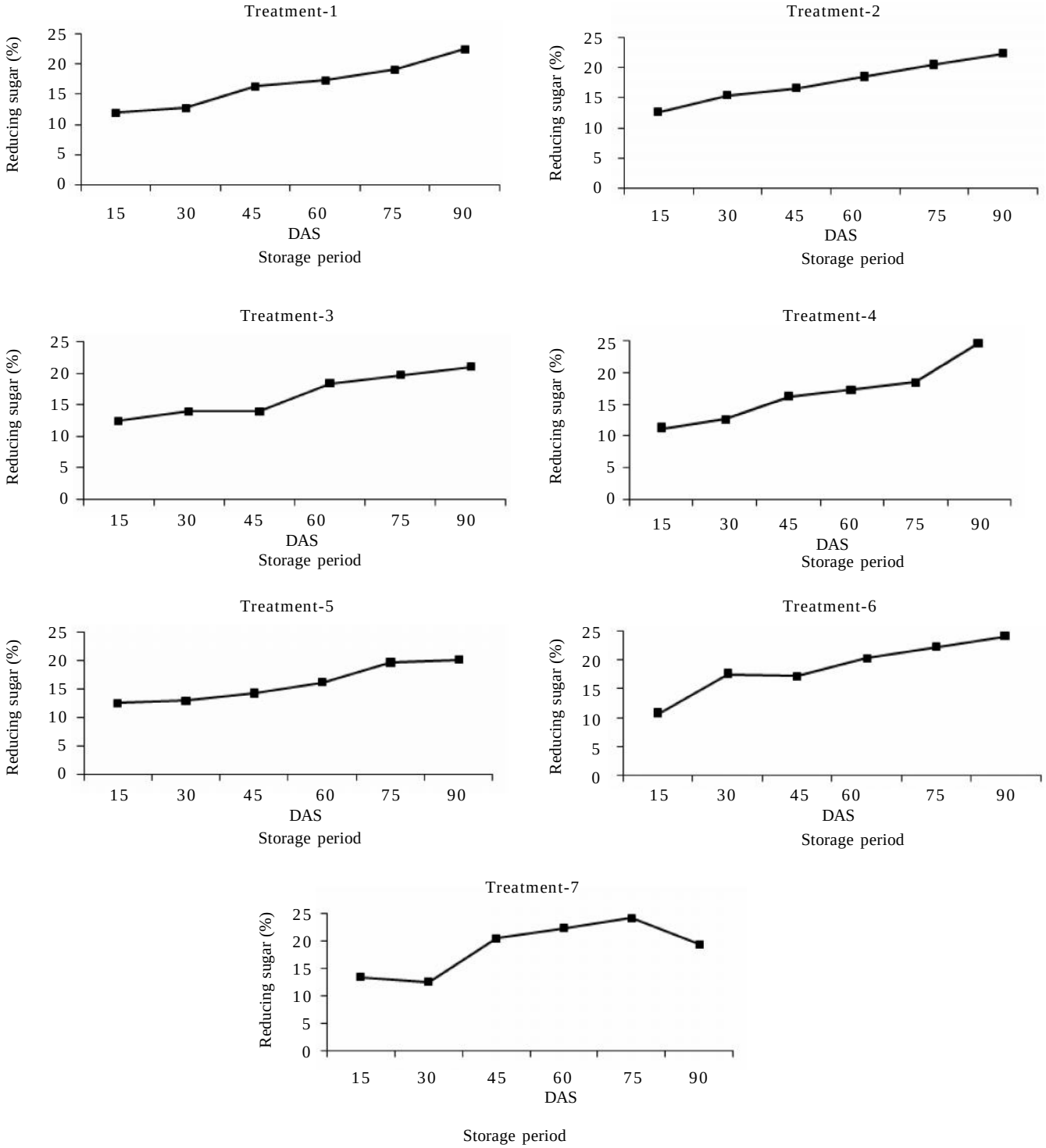

Fig. 3 : Effect of temperature and relative humidity on variation of reducing content during storage

covered by polythene pouch than in the rest of the treatments (Chand *et al.*, 2012).

Purity and Impurity:

Jaggery is consumed through the year and hence, it is essential that good quality jaggery should be supplied to the customers. According to AGMARK the good quality jaggery should be 98 per cent free from impurities. The data in Table 4 reveals that the initially jaggery was stored at 92.5 per cent purity and gradually reduced to

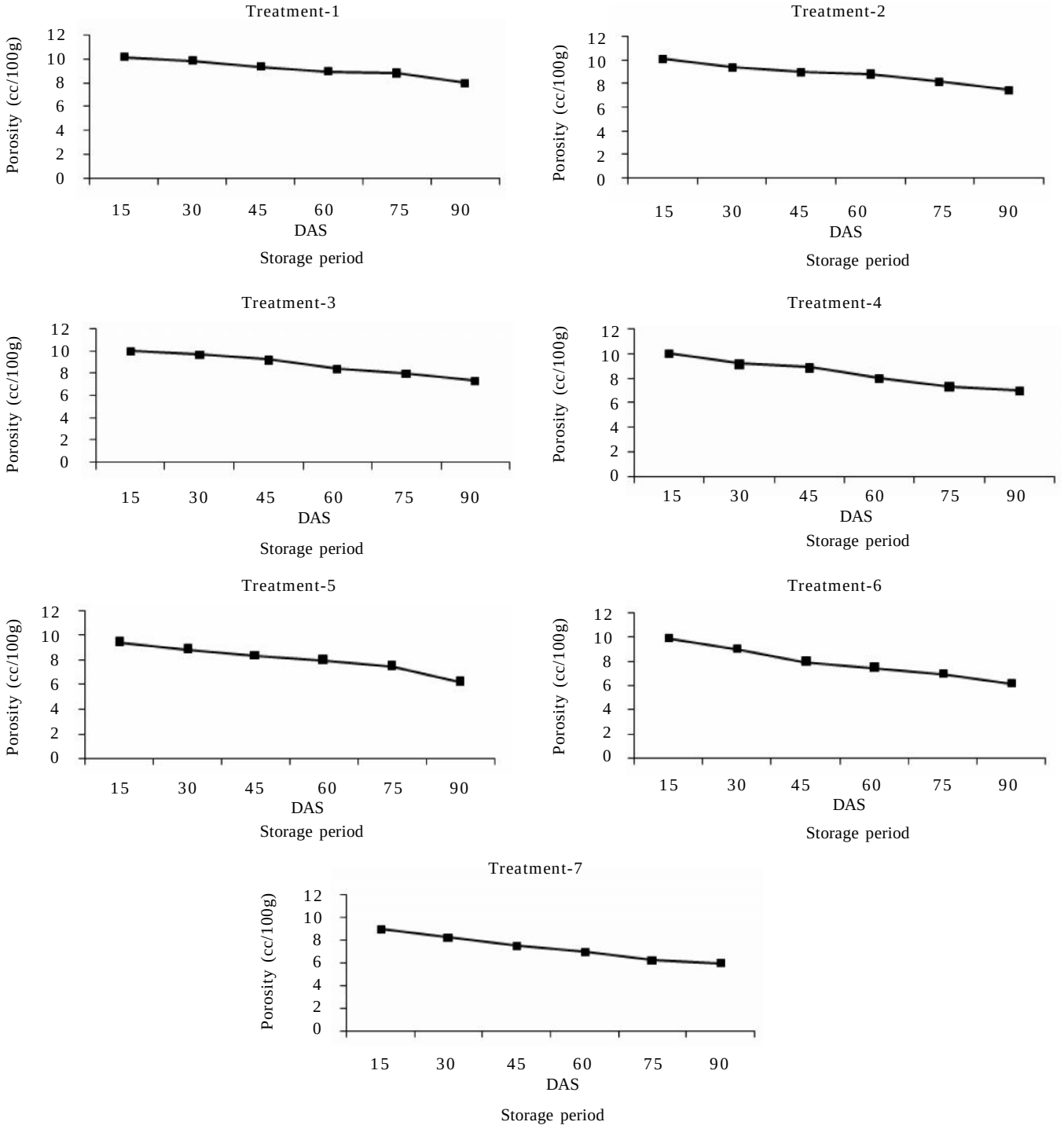

Fig. 4 : Effect of temperature and relative humidity on variation of porosity during storage

around 86-90 per cent at the end of 90 DAS.In jaggery,bagasse particle and mud impurities from the dirt other insoluble affect the quality adversely. According to Usha Ravindra *et al.* (2004) majority of the commercial samples contains more than two per cent impurities, which were above the critical limit prescribed by AGMARK for good quality jaggery. The data Fig.5 reveals that at the time if storage jaggery was stored containing 7.5 per

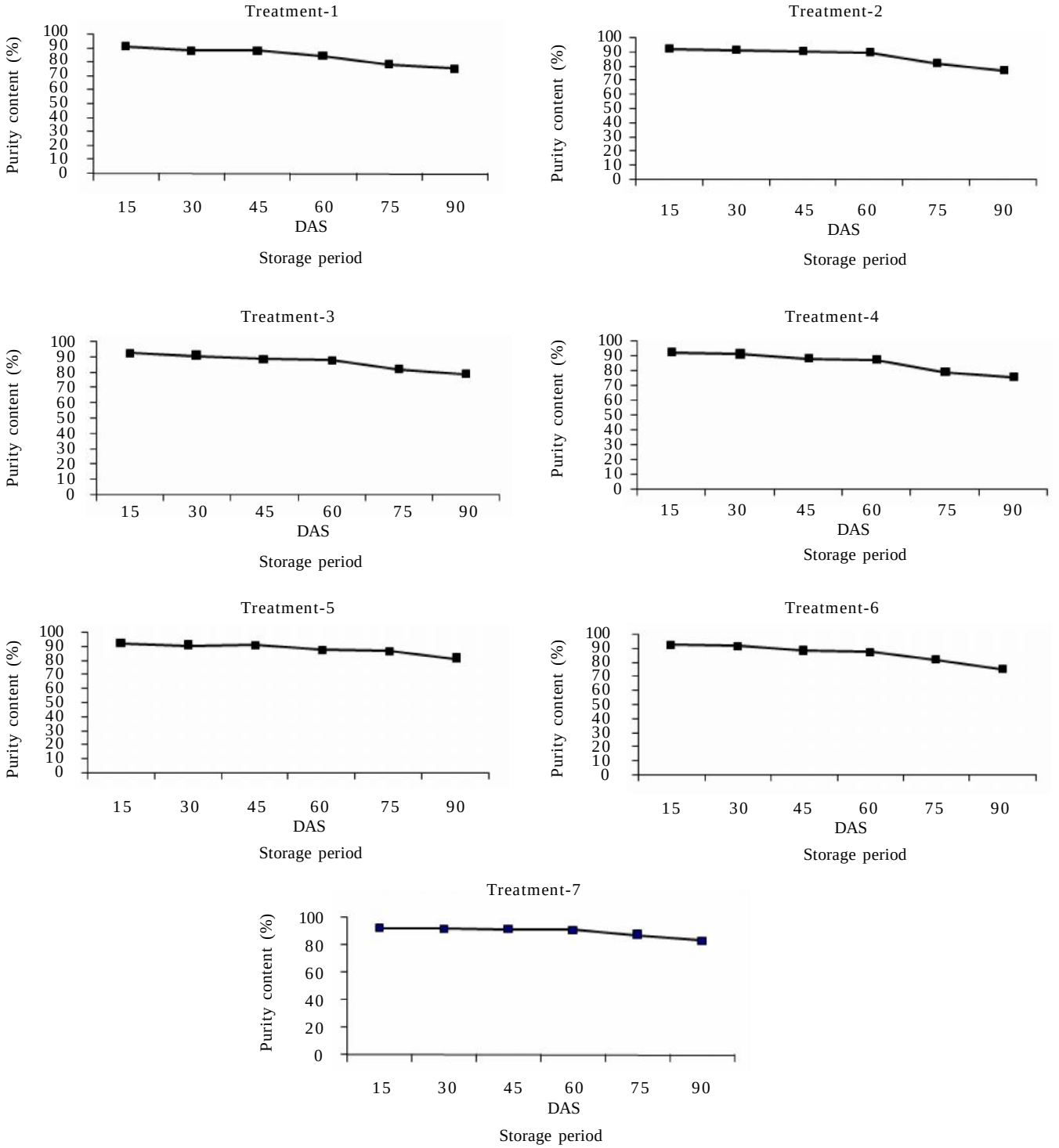

Fig. 5 : Effect of temperature and relative humidity on variation of purity content during storage

cent impurities and gradually increased as the duration of storage increased. This may be due to the absorption of dust and other particles from the surrounding atmosphere handling and storage. Further the data indicates that jaggery stored in air tight container, wrapped with alkathene film and packed in paper box covered by polythene pouch Maintained the initial values of impurities (7.5 %) as compared to the rest of the treatments.

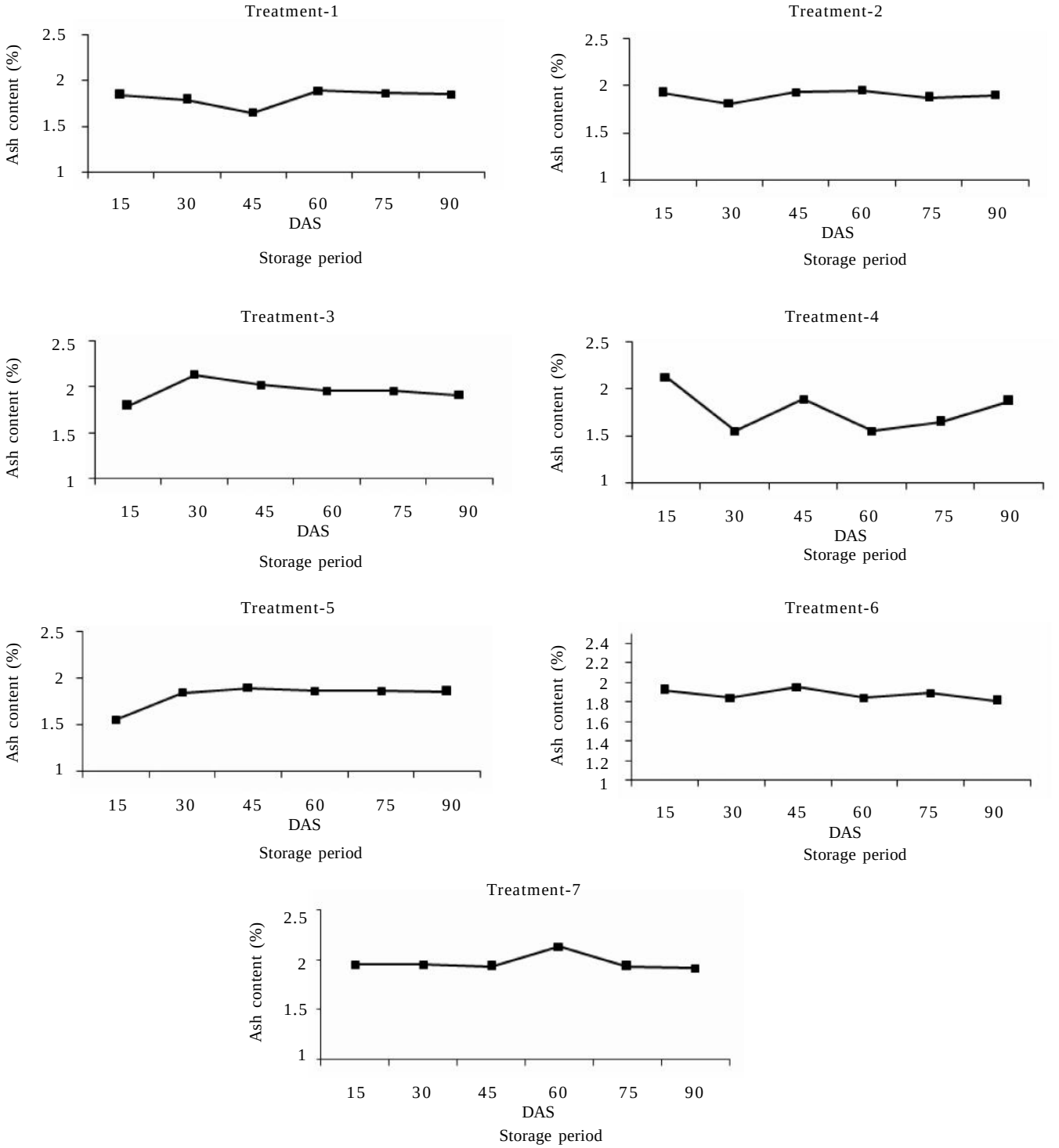

Fig. 6 : Effect of temperature and relative humidity on variation of ash content during storage

Hardness:

Hardness of jaggery depends on the crystalline structure and moisture content. The jaggery with high moisture content becomes soft and deteriorates faster.

The data presented in Fig.7 indicates that the hardness of the jaggery was 5 kg/cm^2 at the time of storing and gradually increased as the duration of storage increased. Kundu and Gupta (1992) stated that hardness

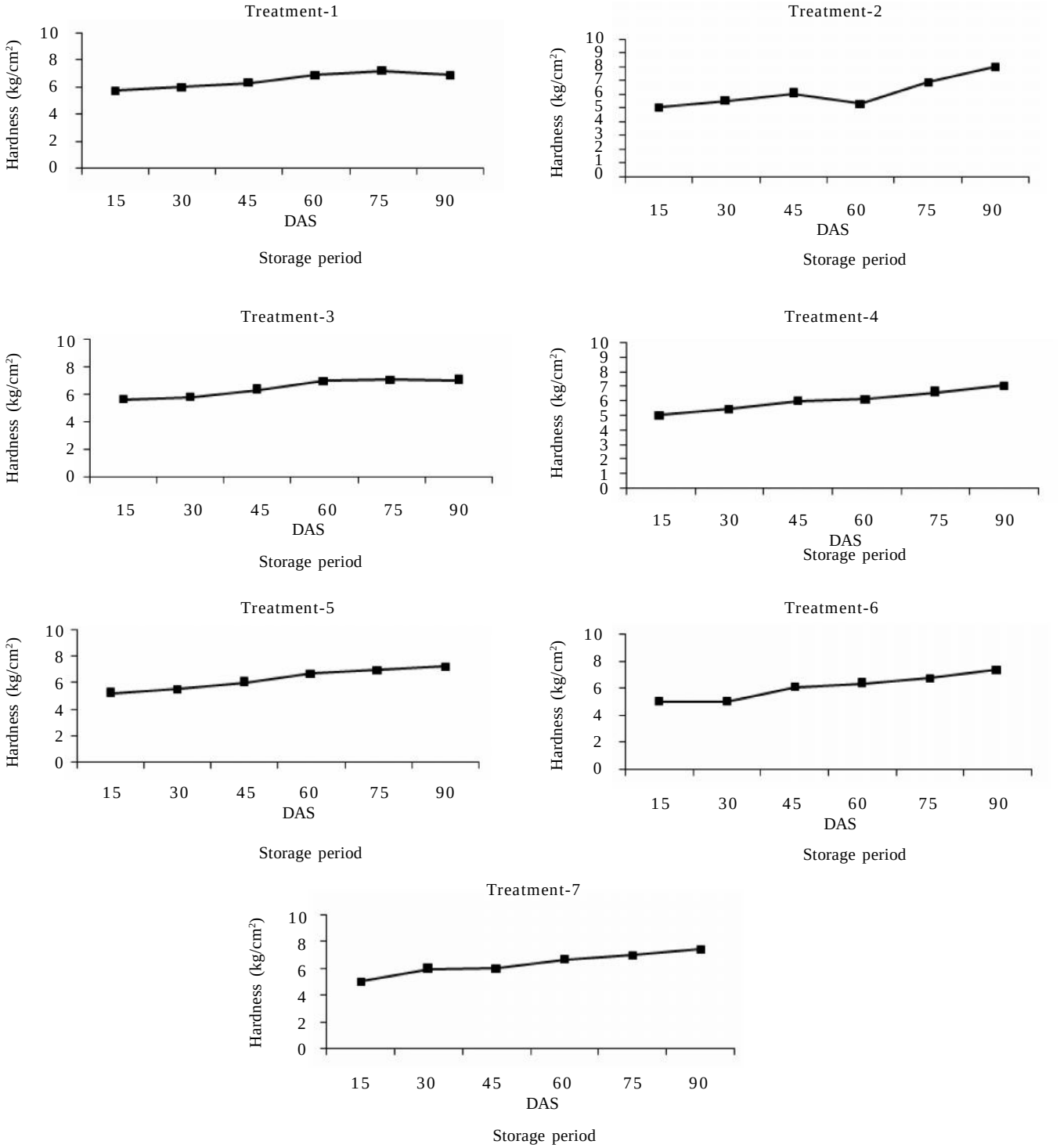

Fig. 7 : Effect of temperature and relative humidity on variation of hardness during storage

of jaggery depends largely on moisture content and jaggery with high moisture content deteriorates faster.

This is probably the reduction of moisture content from 12 per cent to about 5 per cent at the end of 90 DAS hence the jaggery become hard.

Ash content:

The ash content in the standard jaggery should not

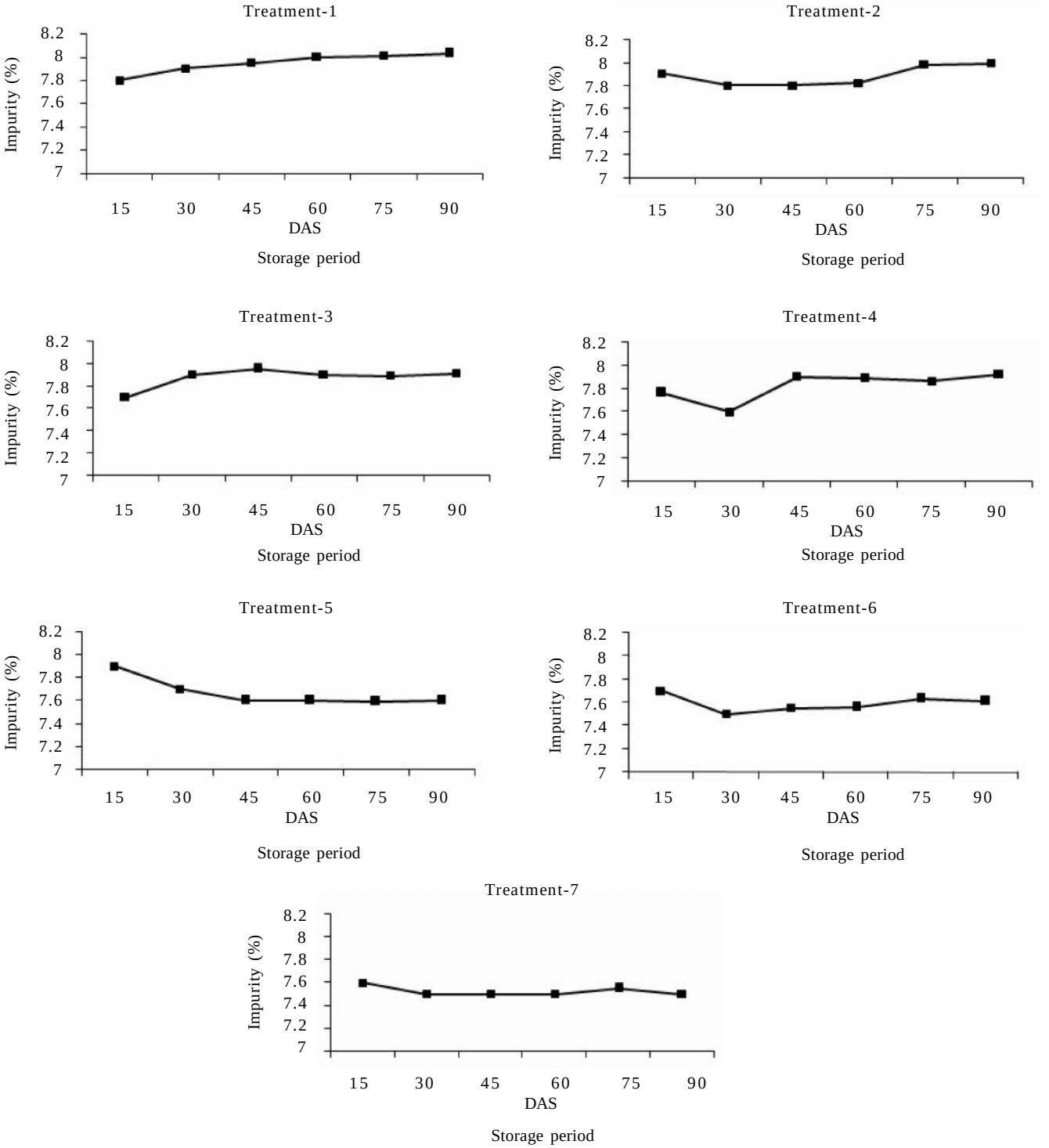

Fig. 8 : Effect of temperature and relative humidity on variation of impurity during storage

exceed 5 per cent (Thakur, 1999). The presence of ash in the jaggery over and above 5 per cent affects adversely the taste of jaggery and also refining quality. The data presented in Fig. 6 indicates that the jaggery with 1.95 per cent ash content was stored initially which was in the safer limit. The per cent of ash content slightly decreased in all the treatments at the end of 90 DAS.

Colour:

The colour of jaggery is one of the important properties to attract consumers and also fetch good market price. Golden yellow (light colour) jaggery is always preferred by the consumers. The data in Table 1 indicates that the jaggery was golden yellow in colour at the time of storage. As the duration of storage increased, the colour of jaggery changed drastically under different storage conditions irrespective of change of moisture content and method of wrapping/packing. The change of colour as the duration of storage increased may be due to oxidation of anthocyanons and the presence of soluble impurities in the jaggery which were not properly removed at the time of preparation.Further, the data indicates that the jaggery stored in air tight container, wrapped with alkathene film and stored, packed in paper box covered by polythene pouch which were not exposed to atmospheric conditions maintained light brown in colour till the end of 90 days. Similar observations were made by Usha Ravindra *et al.* (2004).

Conclusion:

Storage of jaggery by different methods under laboratory conditions for 90 days indicated that moisture content, sucrose content, porosity, hardness, purity and ash content gradually reduced and reducing sugars increased as the duration of storage period increased in all the treatments. Uppal and Sharma (1999) stated that there is a considerable decrease of moisture content, sucrose content, purity and transmittance between fresh jaggery and stored jaggery due to hot and dried whether under which jaggery was stored.

It is observed that the jaggery stored in air tight container maintained its quality and colour closely followed by wrapping with alkathene film and packed in paper box covered by polythene pouch as compared to storing as it is without covering, wrapped with gunny and Hessian cloth or packed with sugarcane trash and stored.

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