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Effect of Blanching on Nutritional Quality of Different Pearl Millet Cultivars

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ABSTRACT: Blanching is one of the most useful hydrothermal treatments, in which various pearl millet grains were treated with hot water at 98 ^{o}C for 30 seconds. Effect of hot water blanching on nutritional quality parameters like polyphenols, fat acidity, acid value, crude fat and reducing sugar content were determined over different storage period. The highest polyphenol content was found in blanched sample of Phule Mahasakti variety 380.78mg/100g, while the lowest was found in Phule Adishakti variety 231.14mg/100g. The fat acidity, acid value, crude fat and reducing sugar of blanched samples of five different pearl millet cultivars ranged from 11.23 to 33.6mg KOH/100g, 1.62 to 19.43 mg KOH/100g, 5.80 to 6.75% and 0.39 to 0.88%, respectively. During the storage of blanched and unblanched samples of different pearl millet cultivars leads to increases in polyphenol, fat acidity, acid value, crude fat and reducing sugar over 0 to 90 days storage period. The major challenge concern with pearl millet is low processing rate due to presence anti nutrients. However, by using advance method of blanching of pearl millet will helps in significant amount of reduction of anti nutrients along with that shelf life of pearl millet grains will also increases by retarding various oxidative reactions like (lipid oxidation).

Keywords: Blanching, Hydrothermal, polyphenols, Reducing sugar and crude fat

INTRODUCTION

Nutritionally, pearl millet makes an important contribution to human diet due to high levels of calcium, iron, zinc, lipids and high quality proteins. Carbohydrates are the major component of pearl millet grains varying from 71.82 to 81.02 per cent (Cheik *et al*., 2006). Pearl millet usually has higher protein and fat content than sorghum or the other millets because the kernel is a naked caryopsis. Its protein content is not only high but also of good quality except for lysine deficiency (Gill, 1991). Protein and fat content of pearl millet varieties vary from 12.25 to 13.09 per cent and 4.32 to 5.11 per cent, respectively (Abdalla *et al*., 2009) and protein digestibility ranges from 47.30 to 61.17 per cent (Anju, 2005). The total sugars in pearl millet ranges from 2.55 to 2.93 per cent, non-reducing sugars ranges from 2.15 to 2.57 per cent and reducing sugars from 0.34 to 0.39 per cent (Rekha, 1997 and Poonam, 2002). Moreover the amino acid and fatty acid profile is also better than other cereals. Pearl millet grain has considerably high level of phytic acid ranging from 603.33 to 678.33 mg/100g and polyphenols 502.78 to 658.30 mg/100g (Anju, 2005). Abdalla *et al.* (2009) analyzed pearl millet grain and reported 4.31-5.30 per cent crude fibre, 1.53-2.00 per cent ash, 450-990 mg phosphorus, 10-80 mg calcium, 7-18.0 mg iron, 5.3-7.0 mg zinc, 1.0-1.8 mg copper and 1.8-2.3 mg manganese content per 100 g grains.

Pearl millet (*Pennisetum glaucum*) is a drought tolerant crop cultivated on about 30 mha in more than 30 countries of five continents *viz.*, Asia, Africa, North America, South America and Australia. It is grown primarily as a food grain in India and Africa. India is the largest producer of pearl millet in the world and its cultivation is next to rice, maize and wheat. It is dual purpose crop of arid and semi-arid areas as it provides cheap food for human, feed for poultry birds and also dry as well as green fodder for cattle. The major pearl millet growing states in order of area are Rajasthan, Maharashtra, Gujarat, Uttar Pradesh and Haryana and these accounts for 87% of the total area under cultivation of pearl millet (Rana *et al*., 2012). In Maharashtra, production area under this crop during kharif-2014-15 was 430 hectare with total production of 730 lakh tones and average yield of 1770 kg/ha (Anonymous, 2015).

The major component of pearl millet grain is starch which may vary from about 50 to75% (Hadimani *et al.,* 2001). Pearl millet starch has lower amylose content than other cereal starches (Serna-Saldivar and Rooney, 1995) and the variability in amylose content of pearl millet starch ranges from 17.0 to 21.5% in some varieties (Taylor, 2004 and Bhupender *et al*., 2013). It is low cost and easily available source of starch. Pearl millet starches have been studied less extensively as compared to other conventional sources of cereal and tuber starches. The pearl millet starch may be a substitute for corn starch (Svegmark and Hermansson, 1993 and Abdalla *et al.,* 2009). In native state, the starch exhibit limited applications due to low shear resistance, thermal decomposition, high tendency towards retrogradation and syneresis which limit its use in some industrial food applications (Singh *et al.,* 2007).

Moist heat i.e. blanching has been reported to be effective in retardation of enzymatic activity and thus improves the shelf-life of pearl millet flour without much altering the nutrient content. Effect of blanching on nutrient composition in endosperm as well as in germ of pearl millet has been studied by Aggarwal (1992) and his results showed reduction in starch content and improvement in in-vitro protein and starch digestibility in both the fraction after six and nine minutes of blanching. It has also been found that blanching reduced polyphenol content of pearl millet by 30 per cent, along with improving shelf-life and colour of pearl millet flour.

Chavan and Kachare (1994) revealed that, fat acidity increased by six folds in untreated pearl millet flour, whereas it remained almost unchanged in the flour obtained from boiling water blanched grains (98^0C for 30 sec) during storage period of 30 days. However, hot water blanching at 98^0C for 10 sec and heating of seeds at 100^0C for 120 minutes were found to be effective to minimize the considerable change in lipids of the meal during storage (Kadlag *et al*., 1994).

Palande *et al*., (1996) reported that, fat acidity of untreated pearl millet cultivars ranged from 16.8 to 53.3 mg/KOH/100g in fresh meal of untreated samples and 213.2 to 611.6mg/KOH/100g in meal after 30 days of storage and this increase was found to be 12 to 19 folds. On the other hand, increase in fat acidity of blanched seeds (98 ^{0}C for 10 sec.) was less than 2 folds in all cultivars during the storage period. They further observed 0.9, 5, 1 and 5 %decline in protein, fat, total sugar and starch digestibility in blanched pearl millet.

Archana *et al.,* (1999) analyzed the effect of blanching on pearl millet grains. Blanching was made for 30 seconds in boiling water at 98 ^{0}C. Results indicated that blanching resulted in significant reduction in polyphenol (28%) and phytic acids (38%). Rekha *et al*., (1999) reported that the blanching reduced polyphenol content of pearl millet by 30 %. Blanching improves the shelf-life and color of pearl millet flour.

Archana *et al.,* (2000) investigated the effect of malting and blanching on the *in-vitro* protein and starch digestibility of pearl millet (*Pennisetum gluacum* L.). Pearl millet seeds were subjected to malting i.e. steeping 16 h, germination for 48 and 72 h, kilning for 24 h at 50°C and blanching (30 s at 98°C) treatments, before grinding to flour and found both the treatments improved in-vitro digestibility significantly.

Arora *et al.,* (2003) studied the efficacy of acid treatment of pearl millet on its mineral contents and HCl-extractability. Pearl millet seeds were subjected to acid treatment by soaking the grains in 0.2 N HCl for 6, 12, 18 and 24 hr. In order to remove acid residues, the acid-soaked grains were washed thoroughly under running tap water, followed by blanching at 98 $^\circ$C for 30 s, and then dried in the sun for 2 days. Mineral contents, especially phosphorus, calcium, and iron, were reduced with the increase in period of soaking of pearl millet in acid, but HCl-extractability improved to varying extents. Acid treatment was thus found to be an effective technique for improving the availability of minerals in pearl millet.

Anu *et al.,* (2006) developed and evaluated the nutritional value of blanched pearl millet flour used in formulation of banana cake. They were used pearl millet (*Pennisetum glaucum* L.), refined wheat flour and green gram (*Phaseolus aureus*) to formulate banana cake. The proximate composition, sugar and mineral content of type-I and type-II banana cake were higher than control banana cake. They concluded that blanched pearl millet flour in combination with refined wheat flour and green gram flour can be successfully incorporated for the development of nutritious banana cake.

Anu *et al*., (2006) studied the effect of blanching of different pearl millet cultivars and found that polyphenol content of pearl millet reduced by 30% along with improving shelf life and colour of pearl millet flour. Mineral contents, especially phosphorus, calcium and iron were reduced with the increase in period of soaking of pearl millet in acid. Acid treatment followed by blanching for 30 seconds was found to be an effective technique for improving available mineral content in pearl millet.

Gunjan (2011) found that, increase in *in vitro* protein digestibility from 54.93 to 58.12 per cent and starch digestibility from 21.70 to 23.35 mg maltose/g, as a result of blanching of pearl millet.

Shobhana *et al.,* (2012) stated that utilization of processing technologies like blanching, parboiling, roasting etc. improved the organoleptic, nutritional and sensory properties of pearl millet.

Bhati *et al.,* (2016) found that, hot water blanching for 90 seconds improved in-vitro iron availability and reduced free fatty acid content; this processing treatment

may be used for development of gluten free convenience food products because it contributed for improvement of color thereby enhancing appearance of the food products.

The present entire investigation was concern with effect of hot water blanching on pearl millet grains and to evaluate the its effect on various nutrients and it was found that blanching effectively reduces polyphenols and free fatty acids whereas, no significant effect on crude fat and reducing sugar. Hence it could be reported that blanching efficiently reduces polyphenols and free fatty acids and eventually increases the storage life of pearl millet grains**.**

MATERIAL AND METHODS

A. Materials

The five different pearl millet varieties were purchased from College of Agriculture, Dhule, (Maharashtra), India. The various chemical regents required for nutritional evaluation were used from Department of Food Science and Technology, MPKV, Rahuri, Maharashtra.

B. Methods

Blanching. Blanching is the hydrothermal process in which grains are submerged in boiling water followed by drying. Blanching could help to reduced antinutritional factors, rancidity and bitterness. Blanching was carried out by the process of Chavan and Kachare (1994). Distilled water was brought to boiling to 98°C in an aluminium container. The grains were subjected to boiling water (1:5 ratio of seeds to boiling water) for 30 seconds and dried at 50 °C for 60 min.

Blanched ground flour sample was kept for storage study up to 30 days. After every 10 days, sample was tested for polyphenol, fat acidity, acid value, crude fat and reducing sugar content. All determinations were carried out by four replications.

Polyphenols. Total polyphenols content was extracted by the method of Singh and Jambunathan (1981).

Fat Acidity. Fat acidity is sensitive and important parameter to determine pearl millet and its products quality. It can be an indicator of biochemical changes during storage of pearl millet hence to determine the fat acidity is very important. It was estimated by the procedure of A.O.A.C. (1990).

Acid value of oil. The acid value of different pearl millet varieties was determined by A.O.A.C. (1990).

Crude Fat. Crude fat content play an important role in determination of storage stability of pearl millet flour. Hence, Crude fat of blanched pearl millet flour was analyzed using Soxhlet apparatus (A.O.A.C., 1995).

Reducing Sugars. Reducing sugars was estimated by Somogyi's modified method (Somogyi, 1945).

RESULTS AND DISCUSSION

A. Effect of Blanching on Nutritional Quality of Different Pearl millet Varieties

Blanching is the hydrothermal process in which grains are submerged in boiling water followed by drying. Blanching could help to reduced antinutritional factors, rancidity and bitterness. Blanching was carried out by the process of Chavan and Kachare (1994). Distilled water was brought to boiling to 98°C in an aluminium container. The grains were subjected to boiling water (1:5 ratio of seeds to boiling water) for 30 seconds and dried at 50°C for 60 min. Effect of blanching on nutritional quality parameters like polyphenols, fat acidity, acid value, crude fat content and reducing sugars of different t varieties of pearl millet flour during storage, over the different storage periods were determined.

1. Polyphenols Content. Polyphenols are one of the important group of compounds, which are having antioxidant properties and which helps avoid the various oxidative reactions by self oxidation and scavenge the free radical formation, however the certain polyphenolic compounds are also showing anti- nutritional properties by binding with certain nutrients (minerals) and making nutrients unavailable, hence to reduce the polyphenol content in pearl millet grains is very important. The blanching is one of the useful hydrothermal processes, which help in significant amount of reduction of polyphenol content and also helps to increase bioavailability of nutrients (Table 1).

The results depicted in Table 1 revealed that, the polyphenol content of blanched and unblanched samples of different pearl millet varieties over different storage periods, showed vast difference due to the blanching treatment. The polyphenols content of unblanched, 0 day stored samples of five different varieties of pearl millet ranged from 304 to 436 mg/100gm, the highest polyphenol content was found in Dhanshakti variety of pearl millet, while lowest was recorded in HC-20. The polyphenol content of 10 days stored, unblanched samples of Phule Adishakti, Dhanshakti, Phule Mahashakti, Pioneer 86M32 and HC-20 varieties of pearl millet were 410.12, 440.13, 440.15, 375.14 and 310.46 mg/100gm, respectively. It was also observed that, increased in storage period was directly proportional to polyphenol content of 30 days stored, unblanched samples of different pearl millet varieties and ranged from 325.71 to 453.14 mg/100gm.

The highest polyphenol content was found in Phule Mahashakti variety (453.14 mg/100gm), followed by Dhanshakti, Phule Adishkti, Pioneer 86M32 and HC-20 varieties of pearl millet over 30 days storage period.

Table 1: Effect of hot water blanching on changes in the polyphenols content (mg/100 g) of different varieties of pearl millet flour during the storage.

Cultivar	Storage (Period)				SE +	CD at 5%
	0 Day	10 Days	20 Days	30 Days		
Phule Adishakti						
Control	403.65 ±.0.49	410.12±0.23	430.12±0.55	445.85±0.23	4.14	12.76
Blanched	231.14±0.12	239.45±0.15	242.15±0.17	250.12±0.33	2.35	7.27
Dhanshkti						
Control	436.65±5.18	440.13±0.23	446.45±0.12	452.36±0.13	1.81	5.58
Blanched	320.45±4.23	322.12±0.15	330.10±0.45	340.12±0.15	1.34	4.12
Phule Mahashakti						
Control	435.32±3.80	440.15±0.15	448.48±0.15	453.14±0.23	4.35	NS
Blanched	365.25±2.21	369.15±0.45	372.78±0.12	380.78±0.78	3.64	NS
Pioneer 86M32						
Control	364.65±.1.15	375.14±0.15	388.16±0.14	398.25±0.15	3.74	11.52
Blanched	280.65±0.23	282.45±0.56	290.78±0.25	300.15±0.23	2.82	8.71
HC-20						
Control	304.17±0.90	310.46±0.45	318.78±0.48	325.71±0.23	8.02	NS
Blanched	280.12±0.15	282.12±0.15	288.15±0.15	295.12±0.15	6.02	NS

*Each value represents average of three determinations.

The results of polyphenol content of unblanched samples of different pearl millet over different storage periods are closely agreement with Elyas *et al*., (2001), Nithya *et al*., (2007), Claire *et al*., (2008), Vanisha *et al*., (2012), Khatak and Grewal (2014), Mamta and Kawatra (2015), Kulthe *et al*., (2016) and Bhati *et al.,* (2016).

In case blanched samples of different pearl millet varieties, it was found that, significant amount of reduction in ployphenol content because during blanching process at 98 °C, the maximum polyphenol content was leached out. The polyphenol content of 0 day stored, blanched samples of Phule Adishakti, Dhanshakti, Phule Mahashakti, Pioneer 86M32 and HC-20 were 231.14, 320.45, 365.25, 280.65 and 280.12 mg/100gm, respectively. whereas, over the 10 day stored, blanched samples of different pearl millet varieties, the highest polyphenol content was found in Phule Mahashakti variety (380.78 mg/100gm) and lowest was recorded in Phule Adishakti variety of pearl millet (250.12 mg/100gm). The polyphenol content of 20 days stored, blanched samples of different pearl millet varieties ranged from 242.15 - 372.78 mg/100gm. It was also observed that, with increased in storage period gradually increased in polyphenol content of blanched samples of pearl millet. The highest polyphenol content was found in 30 days stored, blanched samples of different pearl millet varieties i.e. Phule Mahashakti variety (380.78 mg/100gm) followed by Dhanshakti variety (340.12 mg/100gm) over 30 days storage period.

Significant amount of reduction of polyphenol content in blanched samples of different pearl millet varieties because polyphenols are more soluble in organic solvents, along with that polyphenols are also soluble in water hence, during the blanching process with hot water maximum polyphenol extraction was carried out, polyphenol content was leached out in hot water due to more solubility. Most of the polyphenol content is present in seed coat and husk of pearl millet, during blanching process maximum amount of polyphenol content was leached out from husk, germ and seed coat, hence during the storage of blanched samples of pearl millet flour, slowly increased in polyphenol content over the unblanched samples, at different storage period, hence polyphenol content increment of blanched samples of different pearl millet varieties was lower as compare with unblanched samples during storage.

The results of statistical analysis showed the significant difference in polyphenol content of Phule Adishakti, Dhanshakti, Pioneer 86M32 varieties of pearl millet with respect to their control samples over different storage periods, whereas, no significant difference in polyphenol content was found in Phule Mahahshakti and HC-20 varieties of pearl millet with their control samples. The results of effect of blanching on polyphenol content of different pearl millet varieties are closely agreement with Archana *et al.,* (1999), Rekha *et al*., (1999) and Aggarwal (1992).

2. Fat Acidity. Fat acidity plays an important role in storage stability and quality of pearl millet flour. As storage period increases, the development of fat acidity also get increased and leads to deteriorate quality of flour because of increase in free fatty acids content, hence to determine the fat acidity of pearl millet flour is very important as storage stability point of view. Blanching is one of the hydrothermal process in which pearl millet grains are allow with hot water treatment at 98 degree Celsius for 30 seconds. During blanching process fat acidity of pearl millet get decreased because of heat treatment, the activity of lipase enzyme get reduced and that leads to reduce production of the free fatty acid content and eventually due to inactivation of lipase enzyme, breakdown of lipid molecules get reduce and decrease, the production of free fatty acids and reduce the rancidity of pearl millet flour was observed during storage (Table 2).

Table 2: Effect of hot water blanching on changes in the fat acidity (mg KOH/100g) of different varieties of pearl millet flour during the storage.

Cultivar	Storage (Period)				SE +	CD at 5%
	0 Day	10 Days	20 Days	30 Days		
Phule Adishakti						
Control	16.6±0.25	78.6±0.75	157.1±0.32	233.12±0.52	1.42	4.41
Blanched	15.6± 0.23	22.4±0.25	28.1±0.11	33.6±3.0.22	0.25	0.77
Dhanshkti						
Control	16.7±0.20	88.8±0.58	179.6±0.24	274.9± 0.51	1.66	5.14
Blanched	11.23±1.10	19.6±0.25	22.41±0.23	28.1±1.21	0.20	0.64
Phule Mahashakti						
Control	19.6±0.22	112.2±0.66	241.20±1.21	308.6±0.60	1.99	6.15
Blanched	16.8±0.20	22.4±1.14	24.4±1.10	28.45±1.80	0.22	0.70
Pioneer 86M32						
Control	19.4±0.12	140.8±0.22	252.7±0.25	370.8±0.21	2.30	7.10
Blanched	16.4±0.45	19.10±0.14	22.4±0.33	28.10± 0.31	0.21	0.66
HC-20						
Control	22.4±0.14	101.0±0.79	185.2±0.12	210.4±0.14	1.53	4.72
Blanched	18.6±0.15	22.1±0.80	28.12±0.42	22.4±0.15	0.25	0.78

*Each value represents average of three determinations

The results depicted in Table 2 showed that, the effect of blanching treatment on fat acidity of different pearl millet varieties over different storage period. The fat acidity of unblanched samples of Phule Adishakti, Dhanshkti, Phule Mahashakti, Pioneer 86M32 and HC-20 at zero day storage periods were 16.6, 16.7, 19.6, 19.4 and 22.4mg KOH/100gm, respectively. The HC-20 variety shown highest amount of fat acidity (22.4 mg KOH/100gm), while Phule Adhishakti variety shown lowest fat acidity (16.6 mg KOH/100gm). The fat acidity of 10 days stored samples of five different varieties of pearl millet ranged from 78.6 to140.8 mg KOH/100gm. The pioneer 86M32 showed highest fat acidity followed by Phule Mahashakti, HC-20, Dhanshakti and Phule Adishakti, over 10 days storage period. The fat acidity of 20 days stored, unblanched samples of five different varieties of pearl millet was found higher values over the 10 days stored samples of different pearl millet varieties and ranged from 157.1 to 252.7mg KOH/100gm and highest fat acidity was found in Pioneer 86M32 (252.7mg KOH/100gm). The highest fat acidity was found in 30 days stored, unblanched samples of different pearl millet varieties and ranged from 230.1 to 308.6 mg KOH/100gm. The results of fat acidity of unblanched samples of different pearl millet varieties over different storage periods are similarly matches with Kadlag and Chavan (1993), Palande and Chavan (1994), Dalvi and Chavan (1995), Arora *et al*., (2002), Nantanga *et al*., (2008) and Goyal *et al.*, (2015).

In case of blanched samples of five different pearl millet varieties, it was found that significant amount of reduction in fat acidity, because of destruction of lipase enzyme during blanching process and that reduce the formation of free fatty acids and eventually help in reduction of fat acidity. The fat acidity of blanched samples of all five different varieties of pearl millet at zero day storage periods ranged from 11.23 to18.6 mg KOH/100gm, the highest fat acidity was recorded in HC-20 followed by Phule Mahashakti, Pioneer 86M32, Phule Adishakti and Dhanshakti varieties of pearl millet. Fat acidity of 10 days stored blanched samples of Phule Adishakti, Dhanshakti, Phule Mahashakti, Pioneer 86M32 and HC-20 were 22.4, 19.6, 22.4, 19.1 and 22.1 mg KOH/100gm, respectively. In case of 20 days stored samples pearl millet, the fat acidity ranged from 28.12 to 22.4 mg KOH/100gm. The highest fat acidity was found in 30 days stored, blanched samples of different pearl millet varieties, because of development lipase enzyme activity during storage and breakdown the lipid molecules into free fatty acids. Among five different pearl millet varieties, stored for 30 days, the highest fat acidity was found in Phule Adishakti (33.6 mg KOH/100gm) followed by HC-20, Pioneer 86M32, Phule Mahashakati and Dhanshakti varieties of pearl millet.

The results of statistical analysis showed the significant difference in fat acidity of Phule Adishakti, Dhanshakti, Phule Mahashakti Pioneer 86M32 and HC-20 varieties of pearl millet with respect to their own control sample over different storage period. Above all results of effect of blanching treatment on fat acidity of different pearl millet varieties over different storage period are having closely agreement with Varriano-Marston and Hoseney (1983), Kachare and Chavan (1993), Kadlag *et al.*, (1994), Kaced *et al*., (1984), Lai and Varriano-Marston (1980), Kachare and Chavan (1992) and Bookwalter *et al.*,(1987).

3. Acid Value. The acid value is nothing but amount mg of KOH requires to neutralizes the free fatty acids present in one gm of sample. Acid value gives an idea about amount of free fatty acids present in given sample, hence the acid value plays an key role in storage stability of pearl millet flour, because with increase in acid value leads to produce free fatty acids and that will cause oxidation of pearl millet flour and produce off flavour to flour with decrease the shelf life as well as acceptability of flour.

Table 3: Effect of hot water blanching on changes in the acid value (mg KOH/100g) of different varieties of pearl millet flour during the storage.

Cultivar	Storage (Period)				SE +	CD at 5%
	0 Day	10 Days	20 Days	30 Days		
Phule Adishakti						
Control	3.17±0.25	19.66±0.23	33.33±0.40	40.43±0.14	0.27	0.84
Blanched	1.62±0.12	5.72±0.15	8.03±0.76	8.25±1.20	0.06	0.19
Dhanshkti						
Control	9.95±0.81	46.88±0.14	56.17±0.15	59.12±0.25	0.46	1.42
Blanched	6.25±0.45	13.31±0.14	18.12±0.23	19.43±0.70	0.14	0.45
Phule Mahashakti						
Control	4.43±1.23	19.22±0.13	23.31±0.51	38.08±0.14	0.23	0.33
Blanched	3.09±0.12	5.32±0.22	7.44±0.23	8.12±0.35	0.06	0.19
Pioneer 86M32						
Control	4.43±0.43	12.51±0.15	22.33±0.45	30.45±0.15	0.19	0.60
Blanched	2.63±0.23	4.39±0.41	5.43±0.14	8.59±1.20	0.05	0.7
HC-20						
Control	4.09±0.42	11.51±0.18	21.12±1.55	31.52±2.38	0.19	0.60
Blanched	3.0±0.12	4.51±0.0.21	5.20±1.20	9.01±2.3	0.05	0.17

*Each value represents average of three determinations.

Blanching is one of the most useful hydrothermal treatments, which helps to reduce free fatty acids production in pearl millet flour by lowering the activity of lipase enzyme, due to high temperature (Table 3). The Table 3 showed that, effect of blanching treatment on changes in acid value of different pearl millet varieties over different storage periods, along with, the effect on acid value of unblanched samples of different pearl millet varieties, over different storage period. The acid value of blanched samples of different pearl millet varieties was reduced significantly, over the unblanched samples of pearl millet, because of the heat treatment the activity of lipase enzyme get decreased and help in lowering acid value. The acid value of zero day unblanched, stored samples of different pearl millet varieties*viz.*, Phule Adishakti, Dhanshakti, Phule Mahashakti, Pioneer 84M32 and HC-10 were 3.17, 9.95, 4.43, 4.43 and 4.09 mg KOH/100gm, respectively. The acid value of 10 days stored, unblanched samples of different pearl millet varieties ranged from 11.51 to 46.88mg KOH/100gm. The acid value of unblanched, 20 days stored, samples of different pearl millet varieties ranged from 21.12 to 56.17 mg KOH/100gm, the highest acid value of 20 days stored, unblanched sample was found in Dhanshakti variety, while lowest acids value was recorded in HC-20 variety. The highest acid value was found in 30 days stored, unblanched samples of pearl millet, because of during storage period lipase enzyme act on pearl millet flour and produced free fatty acids and that leads to increase acid value. The acid value of 30 days stored, unblanched sample was highest in Phule Adishakti variety (40.43mg KOH/100gm), while the lowest in Pioneer 86M32 (30.45mg KOH/100gm) variety. Above all results of acid value of unblanched samples of different pearl millet varieties are similarly matches with the Kadlag and Chavan (1993) and Dalvi and Chavan (1995).

In case of blanched samples of different pearl millet varieties, it was found that, the significant amount of reduction in acid value over the unblanched samples of different pearl millet varieties, because of heat treatment leads lowering activity of lipase enzyme and reduce free fatty acid production. The highest acid value was found in Dhanshakti variety of pearl millet (6.25 mg KOH/100gm), followed by Phule Mahashakti, HC-20,Pioneer 86M32 and Phule Adishakti over the zero day storage period. Whereas, the acid value of 10 days stored, blanched samples of five different varieties ranged from 4.39 to 13.31 mg KOH/100gm. The acid value of 20 days store blanched samples of different pearl millet varieties showed the highest acid value was found in Dhanshakti variety (18.12 mg KOH/100gm), while lowest was recorded in HC-20 (5.20 mg KOH/100gm) variety of pearl millet. The acid value for 30 days stored, blanched samples of Phule Adishakti, Dhanshakti, Phule Mahashakti, Pioneer 86M32 and HC-20 were 8.25, 19.43, 8.12, 8.59 and 9.01mgKOH/100gm, respectively. From the results of present investigation, it could be concluded that, significant amount of reduction in acid value of different pearl millet varieties over different storage period due to blanching process.

The results of statistical analysis showed the significant difference in acid value of five different pearl millet varieties *viz*, Phule Adishakti, Dhanshakti, Phule Mahashakti, Pioneer 86M32 and HC-20 with their control sample i.e. unblanched samples. Results of acid value of blanched samples of different pearl millet varieties are closely agreement with (Lai and Varriano-Marston, 1980; Vakharia and Chakraborty, 1984; Halnawar, 1992 and Palande, 1994).

4. Crude Fat. The crude fat content is one of the important components in cereal grain, which acts as medium to provide fat soluble component to human health, however during storage of cereal flour, due to action of lipase enzyme on fat leads to produce free fatty acids and leads to rancidity to cereal flour during

storage. Hence to study of crude fat content is very important for cereals flour and cereal based food products to increase their storage life (Table 4). The results of Table 4 revealed that, the effect of hot water treatment on crude fat content of different pearl millet varieties over different storage periods. The crude fat content of 0 day stored, unblanched samples of Phule Adishakti, Dhanshakti, Phule Mahashakti, Pioneer 86M32 and HC-20 were 6.72, 6.92, 7.52, 6.52 and 6.40%, respectively. The crude fat content of 10 days stored, unblanched samples of different varieties of pearl millet ranged from 6.40 to 7.53% and the highest crude fat content was found in Phule Mahashakti variety (7.53%), while lowest was found in HC-20 (6.40%). There was no increment of crude fat content of 20 days stored, unblanched samples of different pearl millet varieties and ranged from 6.40 to 7.53%. Whereas, the crude fat content of 30 days stored, unblanched samples of different pearl millet varieties, the highest crude fat content was found in Phule Mahashakti followed by Dhanshakti, Phule Adishakti, Pioneer 86M32 varieties of pearl millet. Above all results of crude fat content of unblanched samples of different pearl millet varieties over different storage periods are closely matches with Palande and Chavan (1994), Elyas *et al*., (2001), Ali *et al*., (2002), Hajjagana *et al*., (2014), Obadina *et al*, (2017), Lestienne *et al*, (2005), Osman (2010), Florence *et al*., (2014), Sarang *et al*., (2014), Aisha and Jamuna(2015) and Kirti and Jha (2017).

The crude fat content of blanched, 0 day stored samples of different pearl millet varieties was ranged from 5.80 to 6.74 %, while the crude fat content of 10 days, stored, blanched samples of Phule Adishakti, Dhanshaskti, Phule Mahashakti, Pioneer 86M32 and HC-20 were 6.10, 6.22, 6.74, 6.10 and 5.80%, respectively. In case of 20 days blanched, stored samples of different pearl millet varieties, no significant reduction on crude fat content during storage. In case of 30 days stored, blanched samples of different pearl millet varieties, the highest crude fat content was found in Phule Mahashakti variety (6.75%), while lowest was recorded in HC-20 (5.84%). From present investigation, it was observed that there was no significant amount of reduction in crude fat content of blanched samples of different pearl millet varieties over the unblanched samples during storage except trace amount of fat may leached out during blanching process. The results of statistical analysis showed no significant amount of difference in crude fat content among the five different pearl millet varieties with respect to their control samples i.e. unblanched over different storage period. The results of crude fat content of blanched samples of different pearl millet varieties are closely agreement with Lai and Varriano Marston (1980b), Vakharia and Chakraborty (1984), Halnawar (1992), Sharma and Goswami (1969), Chaudhary and Kapoor (1984), Lai and Varriano Marston (1980a) and Kachare and Chavan(1993).

5. Reducing Sugar. The reducing sugars are those sugars which are having free aldehyde or kenotic group. The reducing sugar content of cereal flour is mainly depends on amount of damaged starch per cent in flour during milling. As storage period increases, the reducing sugar content also got increased because during storage various enzymes like alpha amylase, beta amylase are act on flour starch and convert the complex sugar into simple form and increases reducing sugars.

The Table 5 depicted that, the results of changes in reducing sugar of blanched and unblanched samples of different pearl millet varieties over different storage periods. The reducing sugar of 0 days stored, unblanched samples of different pearl millet varieties ranged from 0.40 to 0.80 %.

Table 4: Effect of hot water blanching on changes in crude fat (%) of different varieties of pearl millet flour during the storage.

Cultivar	Storage (Period)				SE +	CD at 5%
	0 Day	10 Days	20 Days	30 Days		
Phule Adishakti						
Control	6.72±0.23	6.70±0.67	6.74±023	6.75±0.69	0.06	NS
Blanched	6.10±0.11	6.10±0.23	6.12±0.42	6.12±0.12	0.05	NS
Dhanshkti						
Control	6.92±0.76	6.90±0.96	6.94±0.77	6.95±0.14	0.06	NS
Blanched	6.22±0.43	6.23±0.46	6.24±0.44	6.25±0.23	0.06	NS
Phule Mahashakti						
Control	7.52±0.25	7.53±0.23	7.53±0.93	7.54±0.90	0.07	NS
Blanched	6.74±0.68	6.75±0.68	6.75±0.12	6.75±0.68	0.06	NS
Pioneer 86M32						
Control	6.52±0.22	6.50±0.59	6.51±0.59	6.51±0.60	0.06	NS
Blanched	6.10±0.52	6.12±0.43	6.12±0.39	6.12±0.44	0.05	NS
HC-20						
Control	6.40±0.52	6.40±0.57	6.40±0.52	6.39±0.25	0.06	NS
Blanched	5.80±0.78	5.60±0.38	5.60±0.36	5.84±0.84	0.05	0.17

*Each value represents average of three determinations.

Among the five different varieties of pearl millet at 0 day storage period, the highest reducing sugar was found in HC-20 variety and lowest was found Phule Adishakti variety. The reducing sugar of 10 days stored, unblanched samples of Phule Adishakti, Dhanshakti, Phule Mahashakti, Pioneer 86M32 and HC-20 were 0.57, 0.72, 0.81, 0.80 and 0.86%, respectively,(Table 5). Among the all unblanched samples of different pearl millet varieties, the variety HC-20 content highest amount of reducing sugar (0.90%), while lowest was observed in Phule Adishakti (0.76%), over 20 days storage period. The highest reducing sugar content was found unblanched 30 days stored sample, because during storage period, various physicochemical changes occurs in flour like enzyme action on complex sugar leads to produce more reducing sugars. The reducing sugar of 30 days stored, unblanched samples of all different pearl millet varieties ranged from 0.77 to0.93 %. The results of reducing sugar of unblanched samples of different pearl millet varieties are closely agreement with Modu *et al*., (2005), Nithya *et al*., (2007), Osman (2010), Hajjagana *et al*., (2014), Gull *et al*., (2015), Kulthe *et al*., (2016) and Azhari *et al*., (2016).

The reducing sugar content of blanched samples of different pearl millet varieties was not changes significantly over the unblanched samples of pearl millet, except during blanching process trace amount of water soluble sugars may be leached out. The reducing sugar of 0 day stored, blanched samples of Phule Adhishakti, Dhanshakti, Phule Mahashakti, Pioneer 86M32 and HC-20 were 0.39, 0.71, 0.71, 0.68 and 0.75%, respectively. The reducing sugar of 10 days stored, blanched samples of different pearl millet varieties ranged from 0.49 to 0.79%, the highest reducing sugar was found in HC-20 (0.79%) and lowest was recorded in Phule Adishakti (0.49%). The reducing sugar content of 20 days stored, blanched samples of different pearl millet varieties was higher than 10 days stored samples and ranged from 0.50 to 0.80 %. The highest amount of reducing sugar was found in 30 days stored, blanched samples of different pearl millet varieties, over the 10 and 20 days storage period. The HC-20 variety contain highest reducing sugars (0.88%) and lowest was found in Phule Adishakti (0.54%) over 30 days storage period. From above all results, it could be concluded that, no significant effect of blanching treatment on reducing sugar except trace amount of water soluble sugars may leached out during blanching process, however, slowly increased in reducing sugar over different storage periods.

The results of statistical analysis showed the reducing sugar content blanched samples of Dhanshakti variety of pearl millet was having not significant difference over its control sample, whereas, significant difference was found in reducing sugar content of Phule Adishakti, Phule Mahashakti, Pioneer 86M32 and HC-20 varieties of blanched and unblanched samples of pearl millet over different storage period. The results of reducing sugar content of blanched samples of different pearl millet varieties over different storage period are closely related to Subramanian *et al*., (1981), Bhatia *et al*.,(1972), Singh and Popli (1973) and Halnawar (1992).

Table 5: Effect of hot water blanching on changes in reducing sugar (%) of different varieties of pearl millet flour during the storage.

Cultivar	Storage (Period)				SE +	CD at 5%
	0 Day	10 Days	20 Days	30 Days		
Phule Adishakti						
Control	0.40±0.08	0.57±0.06	0.76±0.04	0.77±0.07	0.006	0.01
Blanched	0.39±0.04	0.49±0.04	0.50±0.04	0.54±0.06	0.004	0.01
Dhanshakti						
Control	0.70±0.06	0.72±0.06	0.78±0.07	0.80±0.06	0.007	0.02
Blanched	0.71±0.06	0.70±0.12	0.70±0.07	0.72±0.11	0.006	NS
Phule Mahashakti						
Control	0.74±0.20	0.81±0.12	0.88±0.13	0.90±0.45	0.008	0.02
Blanched	0.71±0.15	0.72±0.52	0.79±0.12	0.82±0.45	0.007	0.02
Pioneer 86M32						
Control	0.71±0.12	0.80±0.20	0.84±0.15	0.89±0.12	0.007	0.02
Blanched	0.68±0.23	0.72±0.26	0.78±0.45	0.80±0.15	0.007	0.02
HC-20						
Control	0.80±0.23	0.86±0.15	0.90±0.12	0.93±0.45	0.008	0.02
Blanched	0.75±0.25	0.79±0.12	0.80±0.23	0.88±0.15	0.007	0.02

*Each value represents average of three determinations.

CONCLUSION

Blanching is one of the most useful hydrothermal treatments, which helps in significant amount of reduction of polyphenol, fat acidity and acid value and aids to increases the shelf life and nutrient availability of pearl millet flour during storage.

Due to blanching process significant amount of polyphenol reduction and which will helps to make nutrient availability like minerals (calcium and phosphorus). During the storage of blanched samples of pearl millet, no significant effect on crude fat and reducing sugars content over different storage period.

FUTURE SCOPE

Blanching is one of the most useful hydrothermal treatment which will helps remove various natural toxicants like polyphenol, along with that it also increases storage stability of pearl millet grains by lowering the free fatty acids and acid value. Hence pearl millet can be utilized into various processed food products with more shelf life.

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