DEVELOPMENT AND EVALUATION OF YOGURT SUPPLEMENTED WITH LENTIL FLOUR

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ABSTRACT

Yogurt is well known and most consumed fermented dairy product due to its health promoting effects and better sensory attributes, but consumers’ demand the value added foods with least defects and more nutrition. Different naturally occurring foods like fruits and lentils have been supplemented in yogurt to enhance the physico-chemical, nutritional and sensorial attributes. In this research milk was supplemented with 1%, 2%, 3% and 4% lentil (Lens culinaris) flour (LF) for development of lentil yogurt; LY1 (0% lentil), LY2 (1% lentil), LY3 (2% lentil), LY4 (3% lentil) and LY5 (4% lentil). The proximate composition of LY included; total solids (TS), solid not fat, crude fat, moisture, crude fiber, ash, nitrogen free extract (NFE) and crude protein. While during storage of 28 days at 4±1º C pH, acidity, water holding capacity, viscosity, synersis and sensory evaluation were recorded to assess the effect of lentil flour on its physico-chemical and sensorial improvement. The proximate composition of LY revealed that as the LF proportion was increased the nutritional profile; mineral contents and protein, was also improved significantly (p<0.01). There was significant (p<0.01) increase in resistance of change of pH and acidity of LY as compared to control. Similarly, LF had highly significant effect on synersis, water holding capacity and viscosity (p<0.01) due to the presence of complex carbohydrates and glycoprotein. Moreover, the sensory evaluation was considerably improved and LY containing 2% LF stood out to be the best sample of LY. Considering outcomes of all the parameters, it is suggested that lentil flour can serve as potential supplement for the value addition of yogurt and other fermented dairy products.

Keywords: Lentil yogurt, viscosity, water holding capacity, synersis

INTRODUCTION

The dairy industry has definitely supreme importance in the food sector. Fermented milk products are well-known globally and have been consumed for hundreds of years. The production of novel varieties of yogurt is relatively new idea if we keep in vision that how faster latest technologies are being advanced from year to another. Yogurt has become unique product as its demand is known globally and have been consumed for

Procurement and Analysis of Raw material

Red lentils and chemical reagents were obtained from market. Buffalo milk was purchased from University Dairy farm, University of Agriculture, Faisalabad. Physico-chemical analysis of milk (pH, acidity, moisture, fat, protein, solids not fat and total solids) and lentil flour (Moisture, crude fat, crude protein, ash, crude fiber Nitrogen free extract) were performed for the determination of proximate composition by following the methods described in AOAC (2012).
Lentil-Yogurt Preparation

Yogurt was prepared by following the method of Kaur et al. (2017) with the addition of 0%, 1%, 2%, 3% and 4% lentil (parched flour) to make treatments; LY0, LY1, LY2, LY3, and LY4, respectively.

Physico-chemical analysis of Lentil-Yogurt

Different chemical analysis (moisture, pH, acidity, crude fat, crude protein, ash, SNF and total solids) of LY were carried out by using the methods of AOAC (2012).

Apparent viscosity

Apparent viscosity of yogurt was measured by following the method described by Sodini et al. (2005) using spindle no.4 of viscometer at 60 rpm for 15 sec. against 100 ml of yogurt sample.

Synthesis

Synthesis was measured by the method adopted by Amatayakul et al. (2006).

Water holding capacity (WHC)

Water holding capacity of LY was assessed in accordance with the method from Chen (2016).

Sensory analysis

Sensory evaluation of lentil flour supplemented yogurt was carried out by using methods described by Meilgaard et al. (2007).

Statistical analysis

Data acquired was subjected to appropriate statistical tools to detect the level of significance as described by Steel et al. (1997).

RESULTS AND DISCUSSION

Raw material analysis

The proximate composition of milk and lentil powder is mentioned in the table: 1, which indicates the percentage means of all proximate components of lentil flour; moisture, crude fat, ash, protein and NFE. Moisture (86.48±0.12), 3.37±0.06, 26.61±1.26, 8.03±0.11 and 51.68±1.25 respectively. Proximate of milk are; moisture, fat, ash, protein, SNF, TS, LR, pH, and acidity; 86.48±0.12, 24.25±0.05, 23.67±0.58, 6.55±0.07 and 0.18±0.02 respectively.

Table 1 Raw material analysis results

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Lentil Flour (means)</th>
<th>Milk (means)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>8.46±0.06</td>
<td>86.48±0.12</td>
</tr>
<tr>
<td>Crude fat (%)</td>
<td>1.86±0.25</td>
<td>4.12±0.10</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>3.37±0.06</td>
<td>0.90±0.03</td>
</tr>
<tr>
<td>Crude protein (%)</td>
<td>26.61±1.26</td>
<td>4.21±0.28</td>
</tr>
<tr>
<td>Crude fiber (%)</td>
<td>8.03±0.11</td>
<td>-</td>
</tr>
<tr>
<td>NFE (%)</td>
<td>51.68±1.25</td>
<td>-</td>
</tr>
<tr>
<td>Solids not Fat (SNF)</td>
<td>-</td>
<td>9.29±0.36</td>
</tr>
<tr>
<td>Total solids</td>
<td>-</td>
<td>13.52±0.12</td>
</tr>
<tr>
<td>Lactometer reading</td>
<td>-</td>
<td>23.67±0.58</td>
</tr>
<tr>
<td>pH</td>
<td>-</td>
<td>6.55±0.07</td>
</tr>
<tr>
<td>Acidity</td>
<td>-</td>
<td>0.18±0.02</td>
</tr>
</tbody>
</table>

It is clearly demonstrated that there were notable variations in the compositional attributes of both raw materials. Moisture (86.48±0.12) content of raw milk was found to be higher than that of lentil flour (8.45±0.06). That is evident of shorter shelf life of milk as compared to lentils’. The results are within the range elaborated by Takruri and Issa (2013). Nitrogen free extract in lentil flour (51.68±1.25) is in accordance with the outcomes described by Kucukceetin et al. (2012).

Proximate analysis of Lentil Yogurt

The effect of lentil flour supplementation on moisture, crude fat, crude protein, crude fiber, ash, solids not fat and total solids was highly significant (p<0.01). Moisture content was decreased in all respective samples of LY; LY0 showed the highest moisture content (86.63±0.10) than LY1 (75.75±0.05%), LY2 (70.67±0.68), LY3 (69.93±2.63) and LY4 exhibited the lowest moisture content (65.49±0.69) among all other samples. The similar decreasing trend was noticed in study performed by Yared, (2013). The trend of ash content was; 0.92±0.03, 0.95±0.02, 0.96±0.07, 1.05±0.07 and 1.09±0.08 in all LY samples; LY0, LY1, LY2, LY3 and LY4 respectively. Similarly, the highest fiber was in LY3 (2.05±0.13) and the lower (0.82±0.03) was in LY4, but control had no fiber in it. The highest protein content (8.36±0.02) was highest in LY4, and other combinations also had more protein content (5.81±0.34 in LY2 and 5.61±0.20 in LY1) than control (3.92±0.18). The protein was increased by gradually enhancing the flour percentage in LY like that of moisture. It was evident that LY3 had highest fat content (5.31±0.08) and other treatments also had more fat content (5.12±0.12 in LY3, 4.98±0.12 in LY4 and 4.55±0.13 in LY2) than control (4.36±0.12). The solids not fat were also positively affected by the LF incorporation; highest SNF were in LY3 (29.00±0.65) followed by LY1 (24.84±1.52), LY2 (24.34±0.61), LY3 (19.70±0.08) and LY0 (9.00±0.21). Lentil flour addition in yogurt caused progressive increase in total solids (p<0.01), this increase in TS content of yogurt is definitely because of higher solids in lentil flour. Highest TS content was noticed in LY3 (34.30±0.61) followed by LY1 (30.09±2.45), LY2 (29.33±0.68), LY4 (24.25±0.05) and control (13.37±0.10). Results of current studies are in accordance with work performed by Yared, (2013).

Table 2 Proximate analysis of Lentil Yogurt

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Percentage Means</th>
<th>Standard deviation (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>86.63±0.10</td>
<td>0.92±0.03</td>
</tr>
<tr>
<td>Ash</td>
<td>3.92±0.18</td>
<td>0.08±0.03</td>
</tr>
<tr>
<td>Fat</td>
<td>4.36±0.12</td>
<td>0.10±0.08</td>
</tr>
<tr>
<td>Protein</td>
<td>6.27±0.03</td>
<td>0.10±0.08</td>
</tr>
<tr>
<td>Fiber</td>
<td>4.55±0.13</td>
<td>0.08±0.08</td>
</tr>
<tr>
<td>TS</td>
<td>13.37±2.45</td>
<td>0.13±0.08</td>
</tr>
<tr>
<td>SNF</td>
<td>9.00±0.21</td>
<td>0.09±0.08</td>
</tr>
</tbody>
</table>

Table 3 Sensory analysis results

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Percentage Means</th>
<th>Standard deviation (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
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</table>

Physico-chemical analysis of Lentil Yogurt:

Effect on pH

The changes in pH of LY are caused due to biochemical changes and microbial growth throughout the incubation and storage period. Statistical data shown that the pH of LY samples were highly significantly different (p<0.01) with lentil flour incorporation all the yogurts showed different pH throughout the storage period. The pH was decreased from 4.50 to 3.88±0.03, 4.00±0.03, 4.12±0.01, 4.11±0.03 and 4.13±0.03 for LY0, LY1, LY2, LY3 and LY4 yogurt samples respectively. Consequences of present study were in line with the results revealed by Chen (2016). The rate of pH decline in LY during storage was noticed to be slower by increasing the lentil flour in respective treatments of LY. The reason for slower rate was more buffering capacity of lentil as compared to milk and the buffering capacity of lentil prevents the drop in pH (Zaree et al., 2012).
Effect on Acidity

The yogurt is produced by action of lactic acid bacteria that convert lactose sugar in lactic acid during fermentation process. Data showed a highly significant (p<0.01) relationship between the acidity and supplementation level of lentil flour. The increasing rate of acidity was indirectly proportional to the quantity of lentil flour in respective treatments of LY. The average acidity at day 1 was 0.786±0.01, 0.752±0.01, 0.747±0.01, 0.744±0.01 and 0.745±0.01 percent for LY0, LY1, LY2, LY3 and LY4 respectively. During storage, the acidity of LY0 sample increased relatively faster as compared to other treatments and the minimum % acidity was recorded in LY4 (0.802±0.01) at day 7. For whole storage period (28 days), similarly retarding effect was noticed in all samples, as maximum acidity was in LY0 (1.030±0.01) followed by LY1 (0.904±0.01) and LY2 (0.859±0.01) while at 21th day minimum acidity was recorded in case of LY4 (0.852±0.01). At the end of storage acidity was; 0.837±0.01, 0.853±0.01 and 0.876±0.01 for LY0, LY1, LY2, LY3 and LY4 respectively. Consequences of present study were in line with the results revealed by Chen (2016), Amatayakul et al. (2006) and Zare et al. (2012).

Effect on Viscosity

Viscosity of yogurt can be described as thickness of sample yogurt. As the total solids increase the viscosity of final product increases but it decreases with the storage. Also the swelling ability of fine particles of flour enhances the viscosity of final yogurt. The average viscosity of LY samples decreased from 2.275±0.09, 2.604±0.04, 2.897±0.09 and 2.371±0.05 to 2.222±0.07, 2.837±0.05, 3.189±0.10, 3.147±0.05 and 3.065±0.07 for LY0, LY1, LY2, LY3 and LY4 respectively, at 7th day of storage. It was observed that the viscosity increased as the level of supplementation in yogurt increased. LY4 had higher viscosity as compared to other samples, while LY0 exhibited minimum thickness among all the yogurt samples. With the passage of time the viscosity showed an altered trend at 14th day viscosity of LY4 decreased suddenly to 2.040±0.07, which was least of all. At the end of storage (28th day) viscosity of yogurt was recorded as; 1.668±0.07, 2.289±0.10, 2.124±0.08, 2.019±0.13 and 1.889±0.06 for LY0, LY1, LY2, LY3 and LY4 respectively, so again LY4 depicted lower viscosity among all the samples with the same level of lentil flour added yogurts but more than control (LY0). Similar trend was observed in study of Amatayakul et al. (2006). Similarly the rate of decrease was observed to be fastest in LY0 and lowest in LY4, while LY1, LY2 and LY3 had relatively better viscosity. There was unusual decrease in LY4 which might be due to exceeded content of lentil flour which undesirably disrupted the structure of yogurt and caused decrease in viscosity (Zare et al., 2012).
quality of yogurt. Pulses have greater WHC due to higher protein content (Singh et al., 2007), so the yogurts with greater proportion of pulses have greater WHC. As well, there were significant differences (p<0.01) among the yogurt samples in water holding capacity. The mean values of water holding capacity for lentil flour added yogurt samples are presented in figure 7 and 8. Addition of lentil flour in yogurt increased the WHC of the yogurt samples as compared to control LY0. The greatest percent water holding ability (42.67±0.58) was observed in yogurt sample LY4, while minimum WHC was in LY0 (26.27±2.08). During storage the WHC was slightly decreased in all treatments but the rate of decrease was faster in control and slower in the LF supplemented yogurt. The trend was 18.33±2.52, 24.33±2.08, 30.33±4.04, 35.33±0.58 and 34.33±2.08 for LY0, LY1, LY2, LY3 and LY4. This result was in line to the consequences recounted for yogurt by Zare et al. (2012) and Amatayakul et al. (2006).

Effect on Sensory of yogurt

Lentil flour supplemented yogurt samples were graded by trained judges using 9-point hedonic scale for selected parameters; as appearance, flavor, aroma, texture, and overall acceptability. It was witnessed that incorporation of lentil flour had highly significant effect (p<0.01) on appearance, significant effect (p<0.05) on flavor, aroma and overall acceptability but non-significant effect (p>0.05) on texture of yogurt while overall acceptability descended as LY0, LY1, LY2, LY3 and LY4 respectively. Appearance is one of the most attracting attributes for yogurt to be approved by the consumers. Average grades for appearance influenced of different supplementation showed that appearance of yogurt was affected non-significantly; maximum scores (8.05±0.69) for appearance were allotted to LY4, followed by LY3 (7.75±0.60) and LY2 while minimum (6.9±0.77) to LY0 as presented in table 4.31. Average values for flavor has presented that highest grades were assigned to LY4 (7.85±0.71) while minimum to LY0 (6.60±0.88). For LY texture, maximum scores (8.05±0.73) were assigned for LY4 followed by LY3 and LY2 (7.80±1.01), while relatively lower scores to LY0 (7.65±0.71) and LY1 (7.46±0.73). Regarding the overall acceptability, LY0 was considered to be best with assigned grades (8.05±0.60), whereas LY4 at the lower level with score (6.90±0.77). Keeping in view the hedonic scale grades, yogurt containing 2% of lentil flour was ranked with the best. The consequences of the current study are in line to the results of Zare et al., (2012) and Amatayakul et al. (2006). So far, it was perceived from current work that addition of lentil flour not only enhanced the nutritive value of the lentil flour supplemented yogurt but also improved the sensory characteristics of the yogurt.

Figure 6 Effect of Storage on viscosity

Figure 7 Effect of Treatments Syneresis

Figure 8 Effect of Storage on Syneresis

Figure 9 Effect of Treatments on Water Holding Capacity

Figure 10 Effect of Treatments on Water Holding Capacity

Effect of Synersis

The data showed highly significant (p<0.01) relationship between the synersis of LF supplemented yogurt and supplementation level of lentil flour. With an increase in percentage of LF for development of yogurt, the synersis of final product decreased in slower rate as compared to the control. This slower decreasing rate of synersis was directly proportional to supplementation level of lentil flour in yoghurt. The data for synersis of lentil yoghurt is given in figure 5 and 6. The average synersis (volume of water in ml per 100 ml) at day 1 was 3.43±0.11, 5.37±0.15, 5.33±0.21, 2.30±0.20, 1.73±0.25 for LY0, LY1, LY2, LY3 and LY4 respectively. During storage minimum synersis was recorded in LY4 (3.57±0.50) while LY0 (6.57±0.25) followed by LY1 (3.47±0.35) and LY2 (4.53±0.51) respectively. But at last day of storage (28th day), minimum synersis was in LY0 (3.47±0.35) followed by LY1 (3.57±0.50) and LY2 (4.53±0.51) while LY3 (6.57±0.25) and LY4 (8.33±0.32) had undesirable whey release. Consequences of present study were in line with the results revealed by Chen (2016) and Amatayakul et al. (2006).

Water holding capacity

Water holding capacity is an ability of food or food ingredient to bind the moisture in it. As the excessive moisture released from yogurt deteriorates the
Table 3 Effect of Lentil flour addition on Sensory Evaluation

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Appearance</th>
<th>Flavor</th>
<th>Aroma</th>
<th>Texture</th>
<th>Overall Acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>LYa</td>
<td>7.70±0.59ab</td>
<td>7.50±1.11ab</td>
<td>7.50±1.11ab</td>
<td>7.65±0.71a</td>
<td>7.60±0.77ab</td>
</tr>
<tr>
<td>LY1</td>
<td>8.05±0.601</td>
<td>7.85±0.71a</td>
<td>7.85±0.71a</td>
<td>7.46±0.73a</td>
<td>7.75±0.59ab</td>
</tr>
<tr>
<td>LY2</td>
<td>7.60±0.77ab</td>
<td>7.10±0.84ab</td>
<td>7.10±0.84ab</td>
<td>7.80±1.04a</td>
<td>8.05±0.60ab</td>
</tr>
<tr>
<td>LY3</td>
<td>6.95±0.86ab</td>
<td>6.80±0.75ab</td>
<td>6.70±0.78b</td>
<td>7.85±0.78b</td>
<td>7.05±0.86b</td>
</tr>
<tr>
<td>LY4</td>
<td>6.90±0.77ab</td>
<td>6.60±0.88a</td>
<td>6.60±0.88a</td>
<td>8.05±0.72a</td>
<td>6.90±0.77a</td>
</tr>
</tbody>
</table>

LYa (0% lentil), LY1 (1% lentil), LY2 (2% lentil), LY3 (3% lentil) and LY4 (4% lentil). Values with similar letters indicate non-significant relationship and dissimilar letters indicate significant relationship, among each other.

CONCLUSION

The goals of current study were well attained and it was clearly evident from the results that lentil is effective supplementation source for value addition of yogurt. In the same way, the LY1 stood out the best quality as well as chemical and structural attributes among all other formulations that is evident through its prodigious potential to overcome the common physical issues of plain yogurt. Results for pH of yogurts during incubation and during storage also supported the development that the developed yogurt will have relatively longer shelf life and better taste which is commonly admired by consumers. The overall sensory evaluation presented better scores for LY1 and LY2 yogurts while LY2 was nominated as best yogurt in terms of overall acceptability by panelists.

Acknowledgment: The research was carried out within the framework of state assignment 40.4419.2017/PCh, using the equipment of the center "Control and management of energy-efficient projects" of the Voronezh State University of Engineering Technologies.

REFERENCES


