JMBFS
Journal of Microbiology, Biotechnology and Food Sciences
International peer-reviewed scientific online journal
Published by Faculty of Biotechnology and Food Sciences

DEVELOPMENT AND EVALUTATION OF YOGURT SUPPLEMENTED WITH LENTIL FLOUR

Faizan ul Haq[1], *Aysha Sameen*[1], *Qamar u Zaman*[1], *Bilal Sajid Mushtaq*[1], *Muhammad Bilal Hussain**[2], *Ahsan Javed*[2], *Sergey Plygun*[3,4,5], *Olga Korneeva*[6], *Mohammad Ali Shariati*[3,4]

Address(es):
[1] National Institute of Food Science and Technology, University of Agriculture Faisalabad, Pakistan.
[2] Institute of Home and Food Sciences, Government College University, Faisalabad.
[3] Researcher, Laboratory of Biocontrol and Antimicrobial Resistance, Orel State University named after I.S. Turgenev, Orel, Russia.
[4] All Russian Research Institute of Phytopathology, Moscow Region, Russia.
[5] European Society of Clinical Microbiology and Infectious Diseases, Basel, Switzerland.
[6] Researcher, Doctor of Biological Sciences, Voronezh State University of Engineering Technologies, Voronezh, Russia.

*Corresponding author: itsmee1919@gmail.com

doi: 10.15414/jmbfs.2019.8.4.1005-1009

ARTICLE INFO

Received 23. 8. 2018
Revised 14. 11. 2018
Accepted 20. 11. 2018
Published 1. 2. 2019

Regular article

OPEN ACCESS

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 physic-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; LY_0 (0% lentil), LY_1 (1% lentil), LY_2 (2%lentil), LY_3 (3% lentil) and LY_4 (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 ± 1^{o} C pH, acidity, water holding capacity, viscosity, synersis and sensory evaluation were recorded to assess the effect of lentil flour on its physic-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 continually increasing in the market due to consumers' approval for a superior standard of living that involves more nutritious food-stuffs (**Codina *et al.*, 2016**). Yogurt is a product, that is prepared in response to the LAB activity causing the milk to ferment, nutritionally it has same value in comparison to the milk, but in yogurt the concentration of nutrients is more (**Wang *et al.*, 2013**) and the digestibility of these nutrients is also better (**Gaetke *et.al.*, 2010**). Yogurt is preferred globally because of its ability to reduce the disorders related to nervous, cardiovascular and gastrointestinal systems (**Crichton *et al.*, 2011; Soedamah-Muthu *et al.*, 2011**). According to **Ozen and Kilic (2009)** consumers are concerned with yogurt not only due to the health promoting effects and nutritional benefits but they are also attracted to its texture, appearance and taste as well. **Lee and Lucey (2010)** confirmed the statement that the physical appearance and texture directly determines the consumers' attraction to yogurt like better viscosity and lesser synersis. **Penna *et al.* (2006)** added the other textural and physio chemical characters like acidity, aroma, texture and appearance. However, there are plenty of different problems associated with the sensory and physical properties which hinder the consumer's preference for yogurt. To enhance these physical and sensory attributes the yogurt is incorporated with different stuffs like fruits, pulses, chocolate, grains and nuts (**Kucukcetin *et al.*, 2012**). Some important leguminous pulses incorporated in yogurt for its physic-chemical development are lentils (**Agil *et al.*, 2013; Zare *et al.*, 2011**), chickpeas, peas, (**Zare *et al.*, 2012, 2013**), beans and quinoa. Supplementing a pulse like lentil in the form of flour in yogurt preparation can improve its quality attributes especially from nutritional point of view. Numerous studies have focused on beneficial components of lentil flour (**Agil *et al.*, 2013; Zou *et al.*, 2011**).

Lentil (*Lens culinaris*) is being acknowledged progressively because of its nutrients profile (**Zou *et al.*, 2011**) and also keeping the compositional attributes under consideration as it has notable content of carbohydrates, fatty acid fiber and protein (**Boye *et al.*, 2010).** There is significant content of complex carbohydrates in lentil like raffinose, inulin and fructo-oligosaccharides which assist the growth of probiotics in fermented milk products, termed as prebiotics (**Zare *et al.*, 2012**).

Keeping all these attributes in view the current research work was planned, focusing on evaluation of effects due to supplementing lentil flour on physiochemical, textural, sensory quality and shelf life of yogurt, like other legumes lentil is also a nutrient rich source having significant amount of raffinose, inulin and other oligosaccharides that have prime importance in promoting functionality and growth of beneficial bacteria. Also the protein profile increases the total solids of final product that could serve as agent to reduce the synersis and increase the firmness and viscosity of yogurt.

MATERIAL AND METHODS

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. Physic-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; LY_0 LY_1, LY_2, LY_3 and LY_4 respectively.

Physic-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.

Synersis

Synersis 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 **Sodini *et al*. (2005).**

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

Subheadings should be used

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, fiber and NFE 8.45±0.06, 1.86±0.25, 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, 4.12±0.10, 0.90±0.03, 4.21±0.28, 9.29±0.36, 13.52±0.12, 23.67±0.58, 6.55±0.07 and 0.18±0.02 respectively.

Table1 Raw material analysis results

Constituent	Lentil Flour (means)	Milk (means)
Moisture (%)	8.45±0.06	86.48±0.12
Crude fat (%)	1.86±0.25	4.12±0.10
Ash (%)	3.37±0.06	0.90±0.03
Crude protein (%)	26.61±1.26	4.21±0.28
Crude fiber (%)	8.03±0.11	-
NFE (%)	51.68±1.25	-
Solids not Fat (SNF)	-	9.29±0.36
Total solids	-	13.52±0.12
Lactometer reading	-	23.67±0.58
pH	-	6.55±0.07
Acidity	-	0.18±0.02

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 **Kucukcetin *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; LY_0 showed the highest moisture content (86.63±0.10) than LY_1 (75.75±0.05%), LY_2 (70.67±0.68), LY_3 (68.93±2.63) and LY_4 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 al LY samples; LY_0, LY_1, LY_2, LY_3 and LY_4 respectively. Similarly, the highest fiber was in LY_4 (2.05±0.13) and the lower (0.82±0.03) was in LY_1 but control had no fiber in it. The highest protein content (8.36±0.02) was highest in LY_4 and other combinations also had more protein content (5.81±0.34 in LY_2 and 5.61±0.20 in LY_1) 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 LY_4 had highest fat content (5.31±0.08) and other treatments also had more fat content (5.12±0.22 in LY_3, 4.98±0.12 in LY_2 and 4.55±0.13 in LY_1) than control (4.36±0.12). The solids not fat were also positively affected by the LF incorporation; highest SNF were in LY_4 (29.00±0.65) followed by LY_3 (24.84±1.52), LY_2 (24.34±0.61), LY_1 (19.70±0.08) and LY_0 (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 LY_4 (34.30±0.61) followed by LY_3 (30.09±2.45), LY_2 (29.33±0.68), LY_1 (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

LY	Percentage Means± Standard deviation (SD)						
	Moisture	Ash	Fat	Protein	Fiber	TS	SNF
LY_0	86.63 ±0.10^a	0.92 ±0.03^a	4.36 ±0.12^b	3.92 ±0.18^c	0^d	13.37 ±0.10^d	9.00 ±0.21^d
LY_1	75.75 ±0.05^b	0.95 ±0.02^{ab}	4.55 ±0.13^b	5.61 ±0.20^b	0.82 ±0.03^c	24.25 ±0.05^c	19.70 ±0.08^c
LY_2	70.67 ±0.68^c	0.96 ±0.07^{ab}	4.98 ±0.12^a	5.81 ±0.28^b	1.40 ±0.03^b	29.33 ±0.68^b	24.34 ±0.61^b
LY_3	68.93 ±2.63^{cd}	1.05 ±0.07^{ab}	5.12 ±0.22^a	6.72 ±1.34^{ab}	1.83 ±0.17^a	30.09 ±2.45^b	24.84 ±1.51^b
LY_4	65.49 ±0.69^d	1.09 ±0.08^b	5.31 ±0.08^a	8.36 ±0.02^a	2.05 ±0.13^a	34.30 ±0.61^a	29.00 ±0.65^a

LY_0 (0% lentil), LY_1 (1% lentil), LY_2 (2%lentil), LY_3 (3% lentil) and LY_4 (4% lentil), TS; total solids, SNF; Solids not Fat.

Physic-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 LY_0, LY_1, LY_2, LY_3 and LY_4 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 (**Zare*et al.*, 2012**).

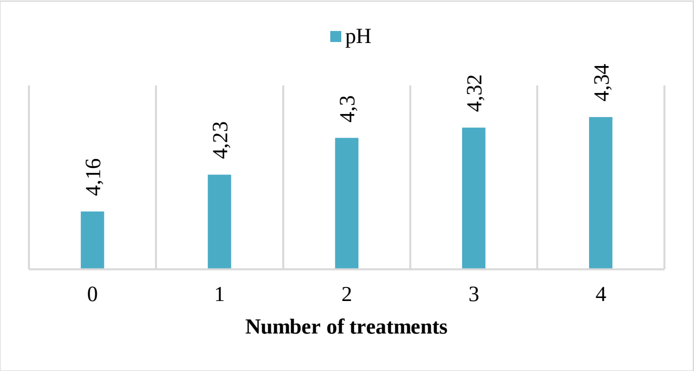

Figure 1 pH trend during Treatments

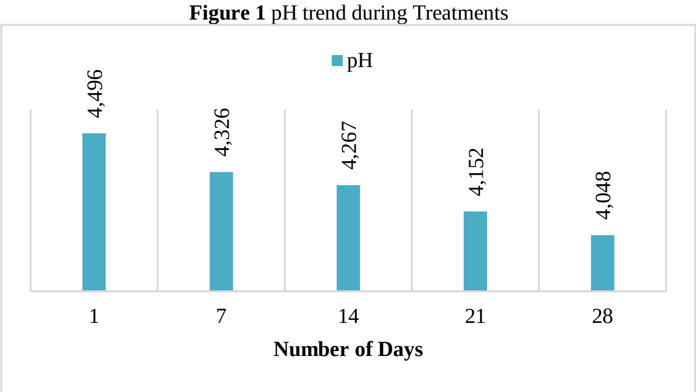

Figure 2 Trend of pH during Storage

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 four. 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 LY_0, LY_1, LY_2, LY_3 and LY_4 respectively. During storage, the acidity of LY_0 sample increased relatively faster as compared to other treatments and the minimum % acidity was recorded in LY_4 (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 LY_0 (1.030±0.01) followed by LY_1 (0.904±0.01) and LY_2 (0.859±0.01) while at 21^{st} day minimum acidity was recorded in case of LY_4 (0.852±0.01). At the end of storage acidity was; 1.035±0.01, 1.006±0.05, 0.879±0.01, 0.853±0.01 and 0.876±0.01 for LY_0, LY_1, LY_2, LY_3 and LY_4 treatments respectively. Consequences of present study were in line with the results revealed by **Chen (2016), Amatayakul *et al.* (2006) and Zare *et al.* (2012).**

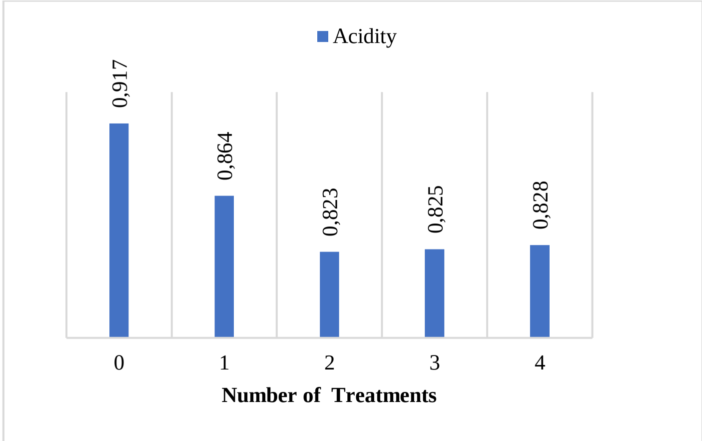

Figure 3 Effect of Treatments on acidity

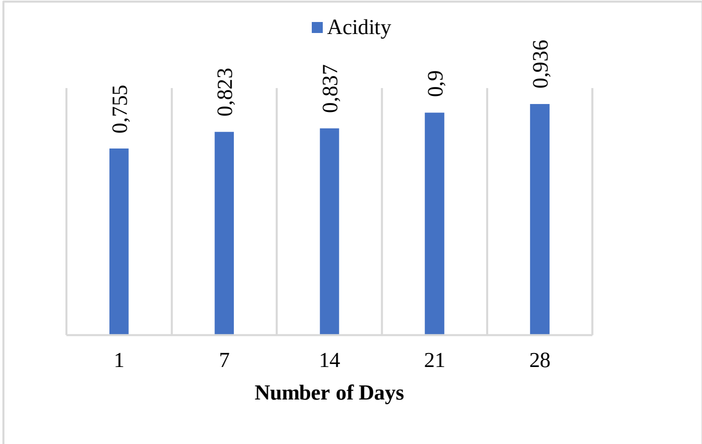

Figure 4 Effect of Storage on Acidity

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±0.09 to 2.222±0.07, 2.837±0.05, 3.189±0.10, 3.147±0.05 and 3.065±0.07 for LY_0, LY_1, LY_2, LY_3 and LY_4 respectively, at 7^{th} day of storage. It was observed that the viscosity increased as the level of supplementation in yogurt increased. LY_4 had higher viscosity as compared to other samples, while LY_0 exhibited minimum thickness among all the yogurt samples. With the passage of time the viscosity showed an altered trend at 14^{th} day viscosity of LY_4 decreased suddenly to 2.040±0.07, which was least of all. At the end of storage (28^{th} 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 LY_0, LY_1, LY_2, LY_3 and LY_4 respectively, so again LY_3 depicted lower viscosity among all lentil flour added yogurts but more than control (LY_0). Similar trend was observed in study of **Amatayakul *et al.* (2006).** Similarly the rate of decrease was observed to be fastest in LY_0 and lowest in LY_4.While LY_1, LY_2 and LY_3 had relatively better viscosity. There was unusual decrease in LY_4 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**).

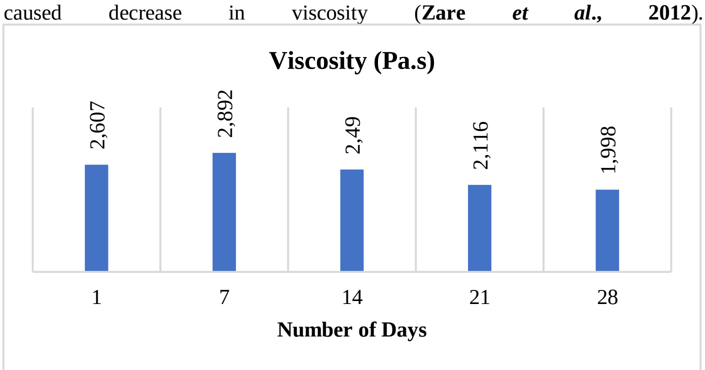

Figure 5 Effect of Treatments on viscosity

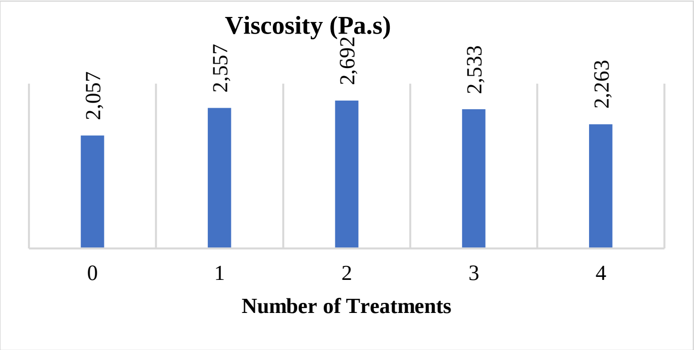

Figure 6 Effect of Storage on viscosity

Effect on Synersis

The data showed highly significant (p<0.01) relationship between the synersis of LF supplemented yogurt and supplementation level of lentil four. 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 yogurt. The data for synersis of lentil yogurt 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 LY_0, LY_1, LY_2, LY_3 and LY_4 respectively. During storage minimum synersis was recorded in LY_4 as1.97±0.40, 2.7±0.36 and 3.47±0.40 at 7th, 14th and 21st day respectively. But at last day of storage (28th day), minimum synersis was in LY_0 (3.47±0.35) followed by LY_4 (3.57±0.50) and LY_3 (4.53±0.51) while LY_2 (6.57±0.25) and LY_1 (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).**

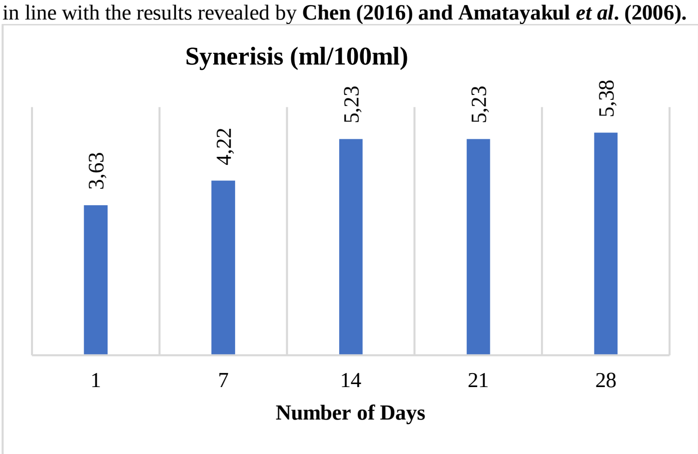

Figure 7 Effect of Treatments Synersis

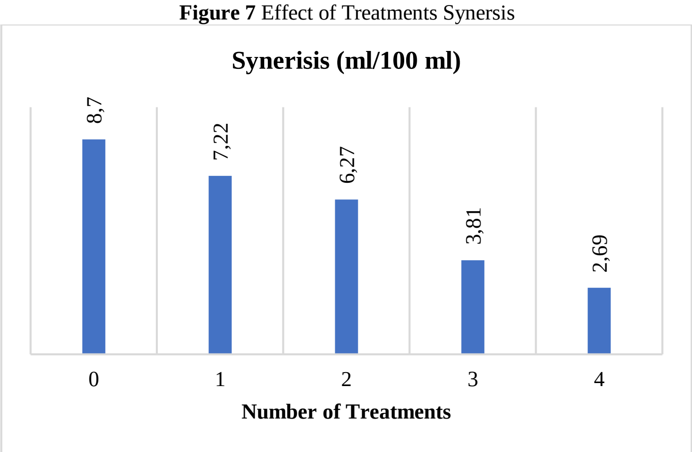

Figure 8 Effect of Storage on Synersis

Effect on 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 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 LY_0. The greatest percent water holding ability (42.67±0.58) was observed in yogurt sample LY_4 while minimum WHC was in LY_0 (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 LY_0, LY_1, LY_2, LY_3 and LY_4. This result was in line to the consequences recounted for yogurt by **Zare *et al*. (2012) and Amatayakul *et al*. (2006).**

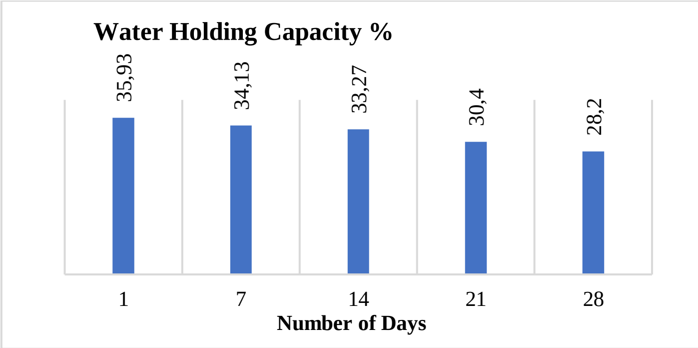

Figure 9 Effect of Treatments on Water Holding Capacity

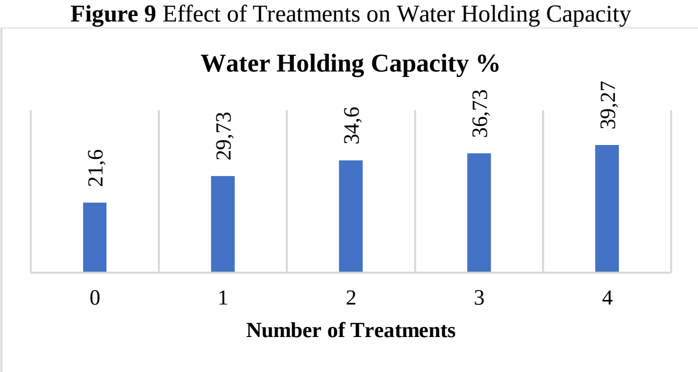

Figure 10 Effect of Treatments on Water Holding Capacity

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 LY_0, LY_1, LY_2, LY_3 and LY_4 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 LY_1 followed by LY_0 (7.75±0.60) and LY_2 while minimum (6.9±0.77) to LY_4 as presented in table 4.31. Average values for flavor has presented that highest grades were assigned to LY_1 (7.85±0.71) while minimum to LY_4 (6.60±0.88). For LY texture, maximum scores (8.05±0.73) were assigned for LY_4 followed by LY_3 and LY_2 (7.80±1.01), while relatively lower scores to LY_0 (7.65±0.71) and LY_1 (7.46±0.73). Regarding the overall acceptability, LY_2 was considered to be best with assigned grades (8.05±0.60), whereas LY_4 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.

Table 3 Effect of Lentil flour addition on Sensory Evaluation

Treatment	Sensory attributes				
	Appearance	Flavor	Aroma	Texture	Overall Acceptability
LY_0	7.70±0.59^{ab}	7.50±1.11^{ab}	7.50±1.11^{ab}	7.65±0.71^{a}	7.60±0.77^{ab}
LY_1	8.05±0.60^{a}	7.85±0.71^{a}	7.85±0.71^{a}	7.46±0.73^{a}	7.75±0.59^{ab}
LY_2	7.60±0.77^{ab}	7.10±0.84^{ab}	7.10±0.84^{ab}	7.80±1.01a^{a}	8.05±0.60^{a}
LY_3	6.95±0.86^{b}	6.80±0.75^{ab}	6.70±0.78^{b}	7.85.±0.78^{a}	7.05±0.86^{b}
LY_4	6.90±0.77^{b}	6.60±0.88^{b}	6.60±0.88^{b}	8.05.±0.72^{a}	6.90±0.77^{b}

LY_0 (0% lentil), LY_1 (1% lentil), LY_2 (2%lentil), LY_3 (3% lentil) and LY_4 (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 LY_4 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 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 LY_1 and LY_2 yogurts while LY_2 was nominated as best yogurt in terms of overall acceptability by panelists.

Acknowledgment: The research was carried out within the framework of state assignment 40.4149.2017/PCh, using the equipment of the center "Control and management of energy-efficient projects" of the Voronezh State University of Engineering Technologies.

REFERENCES

AGIL, R., GAGET, A., GLIWA, J., AVIS, T.J., WILLMORE, W.G., HOSSEINIAN, F. 2013. Lentils enhance probiotic growth in yogurt and provide added benefit of antioxidant protection. *LWT-Food Science and Technology*, 50, 45-49. https://doi.org/10.1016/j.lwt.2012.07.032 .
AMATAYAKUL, T., SHERKAT, F., SHAH و N.P. 2006. Syneresis in set yogurt as affected by EPS starter cultures and levels of solids. *International Journal of Dairy Technology*, 59, 216-221. https://doi.org/10.1016/j.lwt.2012.07.032 .
AOAC. 2012. Official Methods of Analysis of Association of Official Analytical Chemist International. 19th ed. AOAC Press, Maryland, USA. Pp: 10-94.
BOYE, J., AKSAY, S., ROUFIK, S., RIBEREAU, S., MONDOR, M., FARNWORTH, E., RAJAMOHAMED, S. 2010. Comparison of the functional properties of pea, chickpea and lentil protein concentrates processed using ultrafiltration and isoelectric precipitation techniques. *Food Research International*, 43,537-546. https://doi.org/10.1016/j.foodres.2009.07.021 .
CODINA, G.G., FRANCIUC, S.G., MIRONEASA, S. 2016. Rheological characteristics and microstructure of milk yogurt as influenced by quinoa flour addition. *Journal of Food Quality*, 39, 559-566. https://doi.org/10.1111/jfq.12210 .
CRICHTON, G., BRYAN, J., BUCKLEY, J., MURPHY, K. 2011. Dairy consumption and metabolic syndrome: a systematic review of findings and methodological issues. *Obesity Reviews*, 12, 190-201. https://doi.org/10.1111/j.1467-789x.2010.00837.x .
GAETKE, L.M., MCCLAIN, C.J., TOLEMAN, C.J., STUART, M.A. 2010. Yogurt protects against growth retardation in weanling rats fed diets high in phytic acid. *The Journal of Nutritional Biochemistry*, 21, 147-152. https://doi.org/10.1016/j.jnutbio.2008.12.005 .
KAUR, R., KAUR, G., MISHRA, S.K., PANWAR, H., MISHRA, K., BRAR, G.S.. 2017. Yogurt: A nature's wonder for mankind. *International Journal of Fermented Foods*, 6, 57-69. https://doi.org/10.1016/j.jnutbio.2008.12.005 .
KUCUKCETIN, A., EREM, F., KONAK, Ü.İ., DEMIR, M., CERTEL, M. 2012. Effect of lentil flour addition on physical and sensory properties of stirred yoghurt. *Academic Food Journal*, 10, 6-10. https://doi.org/10.1016/j.foodres.2007.11.003 .
LEE, W., LUCEY, J. 2010. Formation and physical properties of yogurt. *Asian-Australasian Journal of Animal Sciences*, 23, 1127-1136. https://doi.org/10.5713/ajas.2010.r.05 .
MEILGAARD, M., CIVILE, G.V., CARR, B.T. 2007. Sensory evaluation techniques. 4th Ed. CRC Press. Boca Raton, FL, USA. 1-464.s
OZEN, A.E., KILIC, M. 2009. Improvement of physical properties of nonfat fermented milk drink by using whey protein concentrate. *Journal of Texture Studies*, 40, 288-299. https://doi.org/10.1111/j.1745-4603.2009.00182.x .
PENNA, A.L.B., CONVERTI, A., DE OLIVEIRA, M.N. 2006. Simultaneous effects of total solids content, milk base, heat treatment temperature and sample temperature on the rheological properties of plain stirred yogurt. *Food Technology and Biotechnology*, 44, 515-519.
SINGH, J., KAUR, L., MCCARTHY, O. 2007. Factors influencing the physico-chemical, morphological, thermal and rheological properties of some chemically modified starches for food applications—A review. *Food Hydrocolloids*, 21, 1-22. https://doi.org/10.1016/j.foodhyd.2006.02.006 .
SODINI, I., MONTELLA, J., TONG, P.S. 2005. Physical properties of yogurt fortified with various commercial whey protein concentrates. *Journal of the Science of Food and Agriculture*, 85, 853-859. https://doi.org/10.1002/jsfa.2037
SOEDAMAH-MUTHU, S.S., DING, E.L., AL-DELAIMY, W.K., HU, F.B., ENGBERINK, M.F., WILLETT, W.C., GELEIJNSE, J.M. 2011. Milk and dairy consumption and incidence of cardiovascular diseases and all-cause mortality: dose-response meta-analysis of prospective cohort studies. *The American Journal of Clinical Nutrition*, 93, 158-171. https://doi.org/10.3945/ajcn.2010.29866 .
STEEL, R.G.D., TORRIE, J.H., DICKEY, D.A.. 1997. Principles and procedures of statistics. A Biometrical Approach. 3rd Ed. McGraw Hill Book Co. Inc., NY. USA.
WANG, H., LIVINGSTON, K.A., FOX, C.S., MEIGS, J.B., JACQUES, P.F. 2013. Yogurt consumption is associated with better diet quality and metabolic profile in American men and women. *Nutrition Research*, 33, 18-26. https://doi.org/10.1016/j.nutres.2012.11.009 .
ZARE, F. 2011. Supplementation of beverage, yogurt and probiotic fermented milk with lentil flour and pea flour and study of the microbial, physical and sensory properties of supplemented products after production during storage. Ph. D. Thesis. Department of biosource engineering. Macdonald campus of McGill University Montreal, Canada.
ZARE, F., BOYE, J., CHAMPAGNE, C., ORSAT, V., SIMPSON, B.. 2013. Probiotic milk supplementation with pea flour: Microbial and physical properties. *Food and Bioprocess Technology*, 6, 1321-1331. https://doi.org/10.1007/s11947-012-0828-3 .
ZARE, F., ORSAT, V., CHAMPAGNE, C., SIMPSON, B.K., BOYE, J.I.. 2012. Microbial and physical properties of probiotic fermented milk supplemented with lentil flour. *Journal of Food Research*, 1, 94-107. https://doi.org/10.5539/jfr.v1n1p94 .
ZOU, Y., CHANG, S.K., GU, Y., QIAN, S.Y. 2011. Antioxidant activity and phenolic compositions of lentil (Lens culinaris var. Morton) extract and its fractions. *Journal of Agricultural and Food Chemistry*, 59, 2268-2276. https://doi.org/10.1021/jf104640k