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Development of Fruit Dahi (Yoghurt) Fortified with Strawberry, Orange and Grapes Juice

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ABSTRACT

Dahi or yoghurt is the most popular milk product owing to its particular physical, nutritional, microbiological and organoleptic properties. The research was conducted to prepare fruit yoghurt fortified with different level of fruit juice (5, 10 and 15%) of different fruits (strawberry, orange and grape). Different physical, chemical and microbiological characteristics were analyzed to assay the quality of the yoghurts. Quality of the yoghurts was improved due to incorporation of low level of fruit juice. Yoghurts fortified with 10% orange juice was the best in quality among the others. The smell and taste, body and consistency and color and texture of the fruit yoghurts were equally acceptable. 10 and 15% strawberry fruit yoghurt contain more acid and its texture was cracked down in refrigeration temperature. The moisture and acidity content of fruit yoghurts were increased than plain yoghurt because of high content of these in the fruits. The fat, protein, carbohydrates and ash content of strawberry and orange fruit yoghurt were decreased than normal plain yoghurt. But the carbohydrates content of grape yoghurt were increased because grape contains more sugar than milk and other two fruits. Statistical analysis showed that yoghurt fortified with 10% orange juice was more acceptable than others comparing all quality characteristics. The microbiological quality of the fruit yoghurts was also acceptable because of acid content of the fruits. In case of strawberry yoghurt, fruit juice concentration more than 5% was not suitable for fruit yoghurt because that are highly acidic and curd was cracked down at refrigerated condition. The findings of this research may give an overall idea about manufacturing of fruit yoghurt incorporating different level of fruit juice and appropriate technology of fruit yoghurt preparation.

Key words: Strawberry, orange, grape, juice, fruit yoghurt, dahi

INTRODUCTION

Dahi is custard like semi solid, acidified dairy product made by fermenting partially evaporated milk with a special culture containing lactic acid producing bacteria (Munzur *et al*., 2004). Dahi is also known as yoghurt in western countries. Of all, cultured milk products, yoghurts are well known and most popular worldwide (Mansour *et al*., 1994). Like milk, yoghurt is a healthy and delicious food due to its high nutritive and therapeutic value (Perdigon *et al*., 2002). Due to low lactose content yoghurt is easily digestible and palatable than milk. Yoghurt is valued for controlling the growth of bacteria and in curing of intestinal disease like constipation, diarrhea and

dysentery, anti-carcinogenic effect and lowering of blood cholesterol (Kamruzzaman *et al.*, 2002). Flavour, texture and aroma of yoghurt depend upon the country of origin as well as other factors including raw materials quality, manufacturing process and the strains involved (Kumar and Mishra, 2004). Good quality yoghurt should be smooth, glossy surface, no crakes or holes on the top of dahi, no whey syneresis, no off flavor or odor, clean layer on the surface of dahi. Dahi or yoghurt is generally considered as a safer product and its unique flavour appeals to so many that consideration is being, given by nutritionists to incorporate inexpensive source of nutrients to make it an almost complete food (Boghra and Mathur, 2000). Preparation of fruit yoghurt has been investigated by a number of researchers in different parts of world (Desai *et al.*, 1994) and (Shukla *et al.*, 1987). But in Bangladesh no research work has yet been done on the manufacture of dahi incorporating strawberry, orange and grape juice. For this reasons the present study was designed to manufacture fruit yoghurt fortified with different levels of strawberry, Orange and Grapes juice with whole milk and to compare their qualities on the basis of physical, chemical and microbial parameters.

MATERIALS AND METHODS

The experiment was conducted from June, 2010 to November, 2011 in the Laboratory of the Department of Food Technology and Rural Industries and Department of Dairy Science, Bangladesh Agricultural University, Mymensingh from June. Fresh milk was collected from Dairy Farm of Bangladesh Agricultural University, Mymensingh. Fruits for juice preparation, sugar and starter culture collected from local market.

Preparation of fruit juice (strawberry, orange and grape): Collected strawberry (*Fragaria alpina*), orange (*Citrus sinensis*) and grape (*Vitis vinifera*) fruits were washed with clean water and the skin was separated with the help of knife aseptically. The seeds were removed from the strawberry and oranges. Black spots were removed from strawberry. Strawberries were blended and oranges and grapes juice was extracted by juicer. After blending, the juice was filtered with clean cloth (hot water washed). These were kept in plastic containers and stored at freezing temperature (-20°C) until preparation of dahi (yogurt).

Preparation of plain dahi (control) and fruit (strawberry, orange and grape) dahi: Whole milk was pasteurized and heated to reduce about one-third of its original volume. Sugar was added to the milk at the rate of 12% after boiling. During heating milk was stirred continuously with the help of a stirrer to avoid formation of cream layer. After desired heating milk pan was taken out from the heater and allowed to cool. When the temperature was about 40°C, then milk was divided into four equal portions and a different type of dahi was prepared from each portion. The fruit (strawberry, orange and grape) juice which is previously pasteurized was incorporated into yoghurt at 5, 10 and 15% level in different cups except control (Nahar *et al.*, 2007). Juice was added before incubation with starter culture as suggested by Guven and Karaca (2002). Milk was inoculated with desirable proportion of starter culture (2%), which was collected from local market. The plastic cups were pre-washed with boiled water before use. The samples were incubated at 37°C until the complete curd formation/coagulation of yoghurt (8-12 h). The yoghurt samples were stored at about 4°C at refrigeration until used.

Physical tests: After complete curd formation, the samples were judged separately by a team of experienced judges for organoleptic parameters including smell and taste, body and consistency, color and texture and data were analyses statistically according to Hossain *et al.* (2011).

Chemical analysis of fresh milk and different types of dahi: Moisture, Total Solids (TS) and ash content of the different type of milk and juice samples were determined according to AOAC (2002). Fat percent was determined by Babcock method using the procedure described by Aggarwala and Sharma (1961). Acidity was determined by titration with 0.1 N sodium hydroxide solution using the procedure by Aggarwala and Sharma (1961). Crude protein was determined by Kjeldahal described by Ranganna (1979) procedure. Total carbohydrate content of the sample was determined by subtracting the measured protein, fat, ash and moisture from 100 (Lopez *et al.*, 1998; Begum *et al.*, 2011). PH was measured with the help of a pH meter (HANNA instruments, HI 8424, microcomputer pH meter). Specific gravity of milk was determined by lactometer.

Microbiological tests: Prepared yoghurt samples were examined for total viable count, total coliform count, total yeast and mold count. For total viable count of bacteria, colony count method was used according to Laboratory Methods in Food Microbiology (Harrigan, 1998). The total number of viable bacteria per gram of yoghurt was obtained by multiplying the number of colony forming units (CFU) on the plate with respective dilution factor and then was converted into logarithmic form. Total coliform (MPN g^{-1}) was counted by MPN method. Yeast and mold count were determined according to the Standard Methods for Examination of Dairy Products by American Public Health Association (APHA, 1998).

Statistical analysis: Analysis was performed by employing statistical package for social science (SPSS version 16) software and excel office program for the statistical analysis of this study. To compare mean values between groups t-test was done as a test of significance.

RESULTS AND DISCUSSION

Chemical analysis of milk: Quality of milk used for yoghurt production was analyzed before use. Moisture, total solid, fat, protein, ash, lactose, acidity pH, solid non-fat (SNF) and specific gravity were determined. Results of chemical analysis of milk are shown in Table 1. The results are more or less similar to other researcher (Osundahunsi *et al.*, 2007). Protein percentage of raw milk samples was 3.3, which is within the normal range of 2.3-4.4 (Osundahunsi *et al.*, 2007). The average specific gravity of milk samples was 1.03 (Table 1), Similar specific gravity value was obtained by Biswas (1997) for Bangladesh Agricultural University, dairy farm milk. Mean acidity of the experimental samples was 0.17% (Table 1) which is within the normal range.

Comparison of physical characteristics of fruit yoghurts: Plain yoghurt (no fruit juice added) was compared with yoghurts incorporating different concentrations (5, 10 and 15%) of juices of strawberry (S_1, S_2 and S_3), orange (O_1, O_2 and O_3) and grape (G_1, G_2 and G_3) for average smell and taste, body and consistency and color and flavor by a team of judges. Results of the organoleptic tests were presented in Table 2.

Yoghurts with 5% fruit juice: Statistical analysis shows that there was significant difference ($p>0.05$) among the smell and taste and body and consistency score of different types of yoghurt.

Table 1: Chemical quality of milk samples

Compositions	Moisture (%)	Total solids (%)	Fat (%)	Protein (%)	Ash (%)	Lactose (CHO) (%)	Acidity (%)	pH	SNF (%)	Sp. gr.
Raw milk	87.46	12.54	4.16	3.32	0.71	4.26	0.17	6.8	8.38	1.029

SNF: Solid non-fat, Sp. gr.: Specific gravity

Table 2: Effect of physical characteristics on quality of plain and different types of fruit yoghurt

	Different types of fruit yoghurt														
	5% fruit juice					10% fruit juice					15% fruit juice				
Physical characteristics	P	S_1	O_1	G_1	LS	P	S_2	O_2	G_2	LS	P	S_3	O_3	G_3	LS
Smell and taste	41.6	39.8	45.5	45.3	**	41.6	33.5	47.8	46.8	**	41.6	28.4	44.6	43.1	*
Body and consistency	26.3	22.6	27.1	27.1	**	26.3	18.7	27.5	26.2	NS	26.3	15.2	27.1	23.8	**
Color and texture	17.2	14.4	19.2	18.9	NS	17.2	12.9	19.4	17.3	**	17.2	10.1	19.2	15.4	NS
Total score	85.1	76.8	91.8	91.3		85.1	65.1	94.7	90.3		85.1	53.7	90.9	82.3	

P: Plain, S_1, O_1, G_1: 5% of strawberry, orange and grape juice, respectively, S_2, O_2, G_2: 10% of strawberry, orange and grape juice, respectively, S_3, O_3, G_3: 15% of strawberry, orange and grape juice, respectively, LS: Level of significance, *Significant at 1% level, **Significant at 5% level, NS: Non significant

Highest smell and taste score (45.5) was recorded in case of yoghurt with 5% orange juice (O_1). On the other hand, lowest score (14.4) was seen in case of yoghurt with 5% strawberry juice (S_1). The 5% grape juice yoghurt (G_1) is also equally acceptable. Similar results were also reported by Keating and White (1990). The highest score of body and consistency (27.1) was found in O_1 and G_1 type yoghurt and the lowest score (22.6) was seen in case S_1 type yoghurt. There was no significant difference among the color and texture scores of different types of fruit yoghurt. From Table 2, the highest score (19.2) was found for O_1 type and the lowest score (14.4) was given for S_1 type of yoghurt. Texture of strawberry fruit yoghurt was crack down due to high content of acid.

Yoghurts with 10% fruit juice: Statistical analysis shows that there was significant difference ($p<0.05$) among the smell and taste scores of different types of yoghurt. Higher smell and taste score (47.8) was recorded incase of O_2 (10% orange) type yoghurt. On the other hand, lowest score (33.5) was seen in case of S_2 (10% strawberry) type yoghurt. The result of this experiment indicates that smell and taste of yoghurt is optimum level due to the addition of 10% orange juice which gave the best result. 10% grape juice yoghurt also gives good quality but not significantly different (Table 2). The result agrees with the work of Desai *et al.* (1994), who found that smell and taste of mango and pineapple yogurt were higher than that of control yoghurt. There was no significant difference among the body and consistency scores of different types of fruit yoghurt with 10% juice.

Optimum body and consistency of yoghurt was found in yoghurt with 10% orange juice. There was significant difference ($p<0.01$) in Color and texture scores of different types of fruit. The highest score was found for 10% orange juice yoghurt. The result of this experiment supports the findings of Desai *et al.* (1994), who observed that addition of fruit juice improved the color and texture score of yoghurt. Considering all the quality parameters the highest score is given to yoghurt with 10% orange juice.

Yoghurts with 15% fruit juice: Average smell and taste scores of yoghurt samples containing 15% fruit juice of strawberry (S_3), orange (O_3) and grape (G_3) were 28.4, 44.6 and 43.1, respectively compared to 41.6 of plain yoghurt (Table 2). Statistical analysis shows that there was significant difference ($p<0.01$) among the smell and taste scores of different types of yoghurt with 15% juice. Higher smell and taste score (44.6) was recorded in case of O_3 type yoghurt. On the other hand, lowest score (28.4) was seen in case of S_3 type yoghurt. The result of this experiment indicates that smell and taste of yoghurt is optimum level due to the addition of 15% orange juice which gave the

Table 3: Effect of chemical characteristics on quality of plain and different types of fruit yoghurt

Chemical characteristics	Different types of fruit yoghurt														
	5% fruit juice					5% fruit juice					5% fruit juice				
	P	S_1	O_1	G_1	LS	P	S_2	O_2	G_2	LS	P	S_3	O_3	G_3	LS
Moisture (%)	74.03	74.06	74.30	73.59	**	74.03	74.19	74.66	73.21	**	74.03	74.29	75.12	72.82	**
Total solids (%)	25.97	25.94	25.69	26.40	**	25.97	25.81	25.33	26.78	**	25.97	25.70	24.79	27.17	**
Acidity (%)	0.66	0.78	0.77	0.74	NS	0.66	0.79	0.78	0.75	NS	0.66	0.81	0.79	0.77	NS
Fat (g)	4.50	4.30	4.27	4.27	**	4.50	4.10	4.05	4.05	**	4.50	3.90	3.82	3.82	**
Protein (g)	3.50	3.36	3.33	3.33	*	3.50	3.22	3.16	3.16	*	3.50	3.08	3.00	3.00	*
CHO (g)	16.60	16.83	16.64	17.37	**	16.60	17.06	16.68	18.14	**	16.60	17.29	16.72	18.91	**
Ash (%)	0.71	0.67	0.68	0.69	**	0.71	0.64	0.66	0.68	**	0.71	0.62	0.64	0.67	**

P: Plain, S_1, O_1, G_1: 5% of strawberry, orange and grape juice, respectively, S_2, O_2, G_2: 10% of strawberry, orange and grape juice respectively, S_3, O_3, G_3: 15% of strawberry, orange and grape juice, respectively, LS: Level of significance, *Significant at 1% level, **Significant at 5% level, NS: Non significant

best result. There was significant difference ($p>0.05$) among the body and consistency scores of fruit yoghurts. From Table 2, the highest score (27.1) was found for O_3 type and lowest score (15.2) was for S_3 type yoghurt. The average color and texture score of yoghurt samples containing P, S_3, O_3 and G_3 fruit yoghurt were 17.2, 10.1, 19.2 and 15.4, respectively (Table 2). There was no significant difference among the color and texture scores of different types of fruit yogurt with 15% juice.

Comparison of chemical characteristics of fruit yoghurts: Chemical characteristics are important indicators of quality measures of prepared yoghurt. Moisture, total solids, total acidity, fat, protein, carbohydrates and ash content of the fruit yoghurt was determined. Results obtained are shown in Table 3.

Yoghurts with 5% fruit juice: Statistical analysis showed that the differences of acidity percentage among 5% fruit yoghurts were not significant ($p<0.01$). Acidity decreased a little due to the addition of different type of fruit juice. The differences in fat percentage between plain yoghurt and yoghurt containing fruit juice were significant ($p>0.05$). Maximum fat percent was seen in plain (P) yoghurt and fat percent was found in fruit yoghurts was nearly equal. Generally fruit contains low level of fat. So, the addition of fruit juice might have decreased the fat percent of fruit yoghurt. There were significant differences in total solids content among the different yoghurt samples. The highest value was recorded in case of G_1 type fruit yoghurt. This indicated that solid content increased with addition of grape juice. Overall ash content of yoghurt with 5% fruit juice was somewhat lower than that of plain yoghurt but differences in ash content between and among the treatments was significant ($p>0.05$). The protein content was decreased due to addition of fruit juice because fruit juice contains lower protein than milk. The protein content did not differ significantly ($p>0.05$) among the different treatments. The carbohydrates content was highest in G_1 type yoghurt and the lowest in plain (P) yoghurt (Table 3).

Yoghurts with 10% fruit juice: The differences of acidity percentage among yoghurts with 10% fruit juice were not significant. Acidity increased a little due to the addition of different type of fruit juice. The differences in fat percent between plain yoghurt and yoghurt containing fruit juice at

10% concentration were significant (p>0.05). Maximum fat percent was seen in plain/control (P) yoghurt and lowest fat percent was found in case of O_2 and G_2 type yoghurt. The highest value of total solid content was recorded in case of plain (P) type and the value was decreased due to addition of juice. Overall ash content of yoghurt with 10% orange juice was somewhat lower than that of plain yoghurt but differences in ash content between and among the treatments was not significant (p>0.05). The average values of protein content of P, S_2, O_2 and G_2 types of yoghurt were 3.50, 3.22, 3.16 and 3.16 g, respectively (Table 3). The protein content did not differ significantly (p>0.01) among the different treatments. Statistical analysis showed that there were significant (p<0.05) differences among the fruit yoghurts with 10% juice as far as carbohydrate is concerned. The carbohydrate content was highest in G_2 type yoghurt and the lowest in plain (P) yoghurt (Table 3).

Yoghurts with 15% fruit juice: The average percentage of acidity of yoghurt samples P, S_3, O_3 and G_3 type were 0.66, 0.81, 0.79 and 0.77, respectively (Table 3). Statistical analysis showed that the differences of acidity percentage among different treatments were not significant. The differences in fat percent between plain yoghurt and yoghurt containing fruit juice at 15% concentration were significant (p>0.05). Maximum fat percent (4.5) was seen in plain yoghurt and fat percent was found to gradually decrease in addition of fruit juice. Difference in the mean total solids percentage was significant among the different yoghurt samples. The highest value (27.17) was recorded in case of 15% grape yoghurt. Overall ash content of yoghurt with 15% levels of grape juice was somewhat lower than that of plain yoghurt but differences in ash content between and among the treatments was not significant (p>0.05). The average values of protein content of P, S_3, O_3 and G_3 types of yoghurt were 3.50, 3.08, 3.00 and 3.00 g, respectively (Table 3). The carbohydrate content was highest in G_3 (15% grape juice) type yoghurt and the lowest in plain (P) yoghurt. Statistical analysis showed that there were significant (p<0.05) differences among the different types of fruit yoghurt in terms of carbohydrate content. As juice concentration increase, the nutrient content of yoghurt also increased.

Comparison of microbiological characteristics of fruit yoghurts: Microbiological characteristics are indicators of safety, quality and shelf life of prepared yoghurt. Total Viable Count (TVC), total coliform count and yeast and Mold count of the fruit yoghurt was determined 0, 5, 7 and 9 days. Results obtained are shown in Table 4-6.

Yoghurts with 5% fruit juice: There was significant difference (p<0.05) in term of total viable organisms count and yeast and mold count among the fruit yoghurts with 5% juice. But differences

Table 4: Microbiological quality of fruit yoghurts with 5% fruit juice

	Different types of fruit yoghurt with 5% fruit juice															
	P				S_1				O_1				G_1			
Parameter	0	5	7	9	0	5	7	9	0	5	7	9	0	5	7	9
TVC, log (CFU g^{-1})	2	5	5.39	5.60	1.6	5.08	5.18	5.48	1.7	5	5.43	5.70	2.1	5.95	6.15	6.55
Coliform (MPN g^{-1})	0	0	10.00	25.00	0.0	0.00	6.00	15.00	0.0	0	6.00	18.00	0.0	0.00	10.00	18.00
Yeast and mold (CFU g^{-1})	0	0	12.00	25.00	0.0	0.00	10.00	35.00	0.0	0	10.00	30.00	0.0	0.00	12.00	40.00

TVC: Total viable count, P: Plain, S_1, O_1, G_1: 5% of strawberry, orange and grape juice, respectively

Table 5: Microbiological quality of fruit yoghurts with 10% fruit juice

	Different types of fruit yoghurt with 10% fruit juice															
	P				S_2				O_2				G_2			
Parameter	0	5	7	9	0	5	7	9	0	5	7	9	0	5	7	9
TVC, log (CFU g^{-1})	1.5	5	5.39	5.60	1.9	5.08	5.20	5.34	2.1	4.95	5.39	5.76	2.2	6	6.08	6.55
Coliform (MPN g^{-1})	0.0	0	10.00	25.00	0.0	0.00	5.00	12.00	0.0	0.00	6.00	20.00	0.0	0	10.00	15.00
Yeast and mold (CFU g^{-1})	0.0	0	12.00	25.00	0.0	0.00	8.00	28.00	0.0	0.00	10.00	22.00	0.0	0	11.00	35.00

TVC: Total viable count, P: Plain, S_2, O_2, G_2: 10% of strawberry, orange and grape juice, respectively

Table 6: Microbiological quality of fruit yoghurts with 15% fruit juice

	Different types of fruit yoghurt with 15% fruit juice															
	P				S_3				O_3				G_3			
Parameter	0	5	7	9	0	5	7	9	0	5	7	9	0	5	7	9
TVC, log (CFU g^{-1})	1.4	5	5.39	5.60	1.6	4.90	5.11	5.30	1.9	5	5.43	5.72	2.1	5.90	6.15	6.48
Coliform (MPN g^{-1})	0.0	0	10.00	25.00	0.0	0.00	0.00	10.00	0.0	0	5.00	18.00	0.0	0.00	7.00	22.00
Yeast and mold (CFU g^{-1})	0.0	0	12.00	25.00	0.0	0.00	0.00	8.00	0.0	0	5.00	15.00	0.0	0.00	5.00	11.00

TVC: Total viable count, P: Plain, S_3, O_3, G_3: 15% of strawberry, orange and grape juice, respectively

in total coliform count between plain and fruit juice yoghurt and among the different level of juice yoghurt were not significant ($p<0.01$). Highest total viable organism (log CFU g^{-1}) was recorded for G_1 type yoghurt and the lowest value was recorded for plain (P) yoghurt (Table 4). Higher organism count in yoghurt with different fruit juice might be due to increased level of juice in yoghurt.

Yoghurts with 10% fruit juice: Table 5 shows that yoghurt with 10% grape juice contain highest number of total viable count, coliform and but yoghurt sample with 10% strawberry juice shows highest number yeast and mold. All organisms were found in low number in plain yoghurt. The differences in coliform count between plain and 10% juice yoghurt were not significant while for other sample it were significant.

Yoghurts with 15% fruit juice: The total viable bacterial count, Coliform count, yeast and mold count of plain yoghurt and yoghurt with 15% strawberry (S_3), orange (O_3) and grape (G_3) were presented in Table 6. Results revealed that except coliform count, differences in other organisms count were significant ($p<0.05$). Lowest coliform count was observed in 15% strawberry juice yoghurt and highest in orange and grape juice yoghurt. Highest total viable organism and yeast and mold count were recorded for 15% grape juice yoghurt and lowest for plain yoghurt.

CONCLUSION AND RECOMMENDATIONS

The research was conducted to develop fortified fruit yoghurt with acceptable physical, chemical and microbiological quality. Three different fruit (strawberry, orange and grape) with three different concentrations (5, 10 and 15%) are used in this experiment. It is obvious from the study that the 10% orange juice (O_2 type) improves the organoleptic quality and chemical characteristics of fruit yoghurt at the refrigeration temperature. On the other hand, all kinds of chemical

characteristics are also acceptable comparing with other fruit yoghurt. The acidity of all fruit yoghurt was increased because fruit (strawberry, orange and grape) contain more acid than milk. The fat, protein and ash content of fruit yoghurt were decreased comparing with plain/control yoghurt because fruit (strawberry, orange and grape) contain lower fat, protein and ash. The moisture content of fruit yoghurt was increased because fruit (strawberry, orange and grape) contain slightly more water than milk. Total solids content fruit yoghurt was decreased because of lower content of total solids. The grape yoghurt contains more carbohydrate than plain/control yoghurt. Fruits which are used for this research purposes contain more acid. For this reason the number of coliform, total viable count, yeast and molds are acceptable but the microbial load is increased highly in normal temperature for the time being and it is not acceptable after 9 days. The strawberry juice contains high amount of acid. For this reason strawberry fruit yoghurt is highly acidic but 5% strawberry juice (S_1 type) yoghurt are acceptable because its pH and acidity is acceptable for human consumption. Above 5% level of strawberry juice is not suitable for fruit yoghurt making. The quality of fruit yoghurt can be improved by proper pasteurization of milk and fruit juice and necessary steps of sanitary conditions.

Yoghurt fortified with 10% orange juice is the best in all quality aspects among the yoghurts formulated in this study. Yoghurts with 5% fruit juice are also of acceptable in quality but varies with each other slightly in organoleptic properties. 15% strawberry juice is not suitable for yoghurt making.

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