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Comparative studies on the qualities of seven brands of vanilla-flavoured stirred yoghurts produced within the Kumasi Metropolis of Ghana

*Adubofuor, J., Dzigbordi B. and Wireku-Manu, F. D.

Department of Food Science and Technology, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

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Abstract

Yoghurt is the main fermented and well-patronized dairy product produced commercially within the Kumasi Metropolis of Ghana. As far as the nutritional composition are concerned, some of the produced yoghurts are either not labeled or inadequately labeled. The aim of the study was to assess and compare the nutritional, physicochemical, microbial and sensory qualities of seven commercialized brands of yoghurts in Kumasi. The brands were coded as Y1, Y2, Y3 up to Y7 and the qualities were analyzed. There were significant differences ($P < 0.05$) in the qualities of the seven brands. The protein content ranged from 2.08 to 3.10% while the fat contents ranged from 0.24 to 0.59%. The energy contents were also from 229 to 338 kJ/100 ml of yoghurt. The total coliforms were from 0 to 9.30×10 cfu/ml and yeast counts also ranged from 8.40×10^5 cfu/ml to 14.00×10^5cfu/ml. These variations could be attributed to the differences in the compositions of the raw materials used and the methods of production. Apart from Y3 which had no coliforms, the microbial levels of the other products did not meet Codex Allimentarius standards for fermented milk products. Comparative study on the sensory evaluation by 30 untrained panelists showed that product Y3 was the least acceptable product while product Y6 turned out to be the most acceptable product followed by product Y5.

Introduction

Yoghurt is a fermented milk product obtained through lactic acid fermentation of milk with a symbiotic culture of *Lactobacillus bulgaricus* and *Streptococcus thermophillus* (Steinkraus, 1997; Tamine and Robinson, 2007). Commercial yoghurt is often available in different forms including set and stirred yoghurt, with stirred yoghurt being the commonest type sold in shops in Kumasi, Ghana. The product has become very popular in Kumasi where it is consumed as a refreshing drink, snack or probiotic food drink (Sanful, 2009). It has been a product which is well patronized by consumers within the Kumasi metropolis and different brands are sold in supermarkets and other shopping centers.

Like any other food product, the quality of yoghurt is a key to its acceptability and marketability. Nutritional, physicochemical and microbial properties are important quality parameters that manufacturers are required to maintain in finished products. Normally all fermented milk products have nutritional values corresponding to the composition of the milk from which they were made, even though small differences in the concentration of chemical constituents could be present due to the manufacturing and fermentation processes as well as the effects of some ingredients used. The main differences that may occur include different concentration of lactic acid and an increase in the content of amino acids and fatty acids (Gambelli *et al.*, 1999). Physicochemical properties such as total solids, total soluble sugars, pH, titratable acidity, viscosity and level of contamination of the final product are all influenced by the manufacturing process and hygienic practices observed during production.

The authenticity and authentication of products are emerging topics within the food sector (Karoui *et al.*, 2004) and are presently a major concern for producers, distributors and consumers alike (Fernandez *et al.*, 2003). One way of ensuring authenticity of food products is by regular assessment of product quality and subsequent publication of information on individual products to protect consumer health and interests. Scientific reports are available for yoghurt products in Italy, Turkey, Nigeria and Sudan (Gambeli *et al.*, 1999; Karagozlu *et al.*, 2005; Dublin-Green and Ibe, 2005; El Zubier *et al.*, 2005). Despite the ever growing popularity of yoghurt produced and sold in the Kumasi metropolis, there is lack of scientific data on the qualities of the yoghurts from different manufacturers. Samples collected from different super markets show either inadequate or lack of display of the nutritional

*Corresponding author.
Email: *jadubofuor@gmail.com*
Tel: +249622839

composition of the products on labels of the different brands produced. The study was therefore carried out to determine and compare the nutritional, physicochemical, microbial and sensory qualities of vanilla-flavoured stirred yoghurt produced and sold within the Kumasi Metropolis, the capital city of the Ashanti Region of Ghana.

Materials and Methods

Collection of samples

Samples of freshly prepared vanilla-flavoured yoghurt produced from low fat milk powder were collected from seven (7) producers within the Kumasi Metropolis and transported to the laboratory in thermos coolers containing ice cubes for analyses. The samples were designated or labeled as Y1, Y2, Y3, Y4, Y5, Y6 and Y7.

Determination of the nutritional composition of yoghurt samples

The Moisture, ash, protein, fat and carbohydrate contents were determined by AOAC methods (AOAC, 2005). The mineral composition was determined after ashing two grams (2 g) of the samples in a Gallenkamp furnace at 500ºC for 2 hours. The ash was dissolved in 5 ml of concentrated hydrochloric acid and diluted to 50 ml with deionized water. The concentrations of Ca, P, Mg, Zn and Fe in the samples were measured by Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). Concentrations of Na and K in the samples were determined by Flame Photometry. The preparation of standards for the determination of sodium and potassium was based on AOAC methods (AOAC method 969.23, AOAC, 2005). The energy content was calculated on the basis of the official conversion factor by using protein energy value of 17 kJ/g; carbohydrate of 17 kJ/g, and fat energy value of 37 kJ/g.

Determination of physicochemical properties of the seven brands of yoghurt samples

Total solids and pH

The pH was measured with an electric digital pH meter (BECKMAN Φ 340 pH/Temp. Meter) and the total solids of samples were determined by the relation: %Total solids = (100 - %Moisture)

Total soluble sugars and titratable acidity

Total soluble sugars (TSS) of samples were determined using hand-held Refractometer (ATAGO Manual Refractometer). The titratable acidity was determined based on AOAC method 990.20 (2005) by titrating samples with 0.1N sodium hydroxide and using phenolphthalein as indicator. The calculation was based on lactic acid which is the main organic acid in yoghurt.

Viscosity of yoghurt samples

The viscosity was determined using a Viscometer (HAAKE Viscotester VT-02). The 100 ml metal beaker of the viscometer was filled with yoghurt at 5°C and the rotor was immersed into it. The viscometer was then switched on and the resistance of the fluid against the applied speed was measured in decipoise (dPs). A value was recorded for all the samples after 20 seconds when the dial remained at the same reading.

Microbial loads of seven brands of yoghurt samples

Samples were analyzed to determine the yeast and total coliform counts. Yeast cells were enumerated by the pour plate method using Yeast Extract Agar (CM0019–OXOID, UK) and incubating at 37°C for 48 hours. Developed colonies were counted with a colony counter (Fankhauser, 2005). Total coliforms were determined using MacConkey broth (CM005-OXOID, UK) in a three-tube Most Probable Number (MPN) method after which the MPN table was used to calculate the total coliforms present in the samples.

Sensory evaluation of seven brands of yoghurt

Thirty (30) untrained panelists evaluated the brands of yoghurt using affective testing. All panelists were familiar with the products and were regular consumers of yoghurt. Seventy (70) milliliters of each brand of vanilla-flavoured stirred yoghurt was poured into coded plastic cups and the sensory characteristics of the products were evaluated based on colour, aroma, sourness, sweetness, thickness and mouthfeel. Panelists were required to evaluate the product on a seven-point hedonic scale with one (1) being dislike very much and seven (7) being like very much. The overall mean scores were determined by computing the averages of the aforementioned sensory attributes.

Statistical analyses

Means and standard deviations of the various parameters of the seven yoghurt samples were determined. One way Analysis of Variance and Fisher's least significant difference (LSD) procedure were used to determine significant differences between means at 95% confidence level. The STATGRAPHICS Centurion XV.I statistical tool was used for the analyses.

Results and Discussion

Nutrient composition of the seven brands of yoghurt

The moisture, fat, protein, ash and carbohydrate contents as well as the energy contents of the vanilla-flavoured yoghurts are represented in Table 1. There were significant differences ($P < 0.05$) in moisture, ash, protein, fat and carbohydrate contents of all the 7 brands of yoghurt. These nutrients ranged from 80.09 to 86.46%, 0.41 to 0.66%, 2.08 to 3.10%, 0.24 to 0.59% and 9.64 to 16.79% respectively. The energy content of the products also differed from one product to the other with product Y3 (the one with the lowest carbohydrate content) having the lowest energy content of 229 kJ/100 g and product Y5 (with the highest carbohydrate content) also having the highest amount of energy of 338 kJ/100 g. The ash contents of the yoghurt samples were generally lower than 0.81% as reported by El Zubeir *et al.* (2005) for plain yoghurt samples and 0.66% as reported by El Bakri and El Zubeir (2009). The variations in ash contents of yoghurts from different manufacturers could be attributed to the compositions of the milk powder used in the production of the product. Products Y1, Y2, Y5 and Y7 had protein contents lower than the minimum permitted amount of 2.7% set by the Codex Standards for yoghurts (Codex Standard 243-2003). The fat contents of all the seven products studied were far lower than those reported for similar products by Younus *et al.* (2002) and El Bakri and El Zubier (2009). These researchers reported values in the ranges of 2.94 – 3.50% and 2.75 – 3.82% respectively. The fat contents were also generally below the recorded value of 1% for low fat yoghurt but slightly higher than that of fat-free diet yoghurt (0.2%) (The Dairy Council-www.milk.co.uk/page.aspx?intPageID=196).

Table 1. Nutrient content of 7 brands of vanilla-flavoured yoghurt

Brand of yoghurt	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Carbohydrate (%)	Energy (kJ)/100 g
Y1	85.45 ± 0.19^{a}	0.50 ± 0.08^{a}	2.19 ± 0.07^{a}	0.44 ± 0.04^{ab}	11.54 ± 0.40^{a}	250
Y2	84.94 ± 0.20^{b}	0.42 ± 0.10^{a}	2.27 ± 0.35^{a}	0.27 ± 0.18^{a}	12.43 ± 0.16^{b}	260
Y3	86.46 ± 0.05^{c}	0.46 ± 0.03^{a}	3.10 ± 0.19^{c}	0.34 ± 0.01^{ab}	9.64 ± 0.14^{c}	229
Y4	85.71 ± 0.02^{d}	0.41 ± 0.03^{a}	2.77 ± 0.08^{b}	0.24 ± 0.19^{a}	10.87 ± 0.29^{d}	241
Y5	80.09 ± 0.06^{e}	0.44 ± 0.02^{a}	2.35 ± 0.08^{a}	0.34 ± 0.02^{ab}	16.79 ± 0.05^{e}	338
Y6	82.25 ± 0.09^{f}	0.66 ± 0.03^{b}	3.04 ± 0.08^{bc}	0.59 ± 0.41^{b}	13.45 ± 0.58^{f}	302
Y7	83.69 ± 0.14^{g}	0.46 ± 0.03^{a}	2.08 ± 0.0^{a}	0.44 ± 0.05^{ab}	13.34 ± 0.22^{f}	278

Mean values with different superscripts in the same column show significant differences ($p < 0.05$)

In Ghana, local laws (Ghana Standard 337-2003) require that yoghurts with this level of fat be designated Skimmed yoghurt, and this generally places them in a category close to fat free or diet yoghurts and makes them a good choice of refreshment for individuals on low fat diets. The energy contents were close and also within values of plain yoghurts and some other fermented milk products reported by Gambelli *et al.* (1999) which ranged from 262 – 402 kJ/100 g. The values were also close to those specified by the Dairy Council for plain low fat (237 kJ/100 g) and fat free/diet (230 kJ/100 g) yoghurts (The Dairy Council-www.milk.co.uk/page.aspx?intPageID=196).

The mineral contents of the brands of yoghurt are shown in Table 2. The mean values of the minerals analyzed differed significantly ($p < 0.05$). The predominant minerals present in all the seven products were calcium and phosphorus which ranged from 1122.58 to 1486.39 mg/kg and 855.71 to 1086.17 mg/kg respectively. The potassium content also ranged from 206.00 mg/kg to 542.90 mg/kg. The values obtained confirm the reports that calcium is the major mineral in milk and milk products followed by phosphorus and that yoghurt is an excellent source of potassium and calcium (Dairy Council of California, 2009; French Dairy Board, 2007). Magnesium ranged from 174.56 to 347.01 mg/kg and sodium ranged from 261.22 mg/kg to 358.57 mg/kg. The lowest mineral content in all products was iron followed by zinc. The values of these minerals ranged from 0.728 to 1.058 mg/kg and 3.57 to 5.40 mg/kg respectively. Essential minerals present in milk products vary in levels depending on technological treatments of the products, the type of milk base used and the accuracy of analyses (Miller *et al.*, 2000). The major nutritional interest in milk and milk products may lie in their natural richness in calcium but they are also among the main suppliers of phosphorus, iodine, magnesium, zinc and selenium. (French Dairy Board, 2007).

The physicochemical properties of the 7 brands of yoghurt are shown in Table 3. There were significant differences ($p < 0.05$) in the properties of the seven brands of yoghurt. The pH of all yoghurts analyzed ranged from 3.92 to 4.45 and were either close or within the expected ranges of 4.3 to 4.4 or 3.8 to 4.2 for fully fermented stirred yoghurt (Adams and Moss, 1995; Nauth, 2004). The titratable acidity of all the products satisfied the minimum recommended value of 0.6% set by Codex Standards for yoghurt and related products. The titratable acidities of all the brands of vanilla-flavoured yoghurts were similar to the range of values of 0.87 to 1.13% reported by Younus *et al*. (2002). The titratable acidity of a good finished yoghurt product is reported to be around 0.85-0.90% (Jay *et al.*, 2005). Product Y1 was within this range and the titratable acidities of 0.93 and 0.92% for product Y2 and Y6 respectively were the most closest. The fact that the brand with the highest total solids (Y5) also had the highest percentage acidity confirm reports that an increase in total solids causes a corresponding increase in the rate of acidification or pH reduction during

Table 2. Mineral content of the 7 brands of vanilla-flavoured yoghurts in mg/kg

Brand of yoghurt	Ca	P	Mg	Na	K	Fe	Zn
Y1	1486.39 ± 3.46^{a}	855.71 ± 4.05^{a}	208.86 ± 3.00^{a}	296.86 ± 1.14^{a}	294.50 ± 0.68^{a}	0.8734 ± 0.01^{a}	4.69 ± 0.30^{ab}
Y2	1320.85 ± 6.72^{b}	1019.19 ± 6.58^{b}	212.60 ± 3.47^{a}	416.46 ± 17.36^{b}	542.90 ± 2.45^{b}	0.9982 ± 0.01^{b}	5.40 ± 0.19^{e}
Y3	1122.58 ± 1.92^{c}	913.85 ± 6.50^{c}	219.45 ± 6.87^{b}	261.22 ± 6.08^{c}	339.14 ± 9.11^{c}	0.8449 ± 0.01^{a}	4.31 ± 0.25^{ac}
Y4	1443.81 ± 3.95^{d}	1039.86 ± 0.73^{d}	347.01 ± 3.05^{c}	295.47 ± 4.34^{a}	206.00 ± 4.32^{d}	1.0576 ± 0.01^{c}	3.57 ± 0.20^{d}
Y5	1381.14 ± 2.34^{e}	892.50 ± 5.56^{e}	213.76 ± 2.69^{ab}	312.66 ± 3.37^{d}	446.73 ± 4.22^{e}	0.7283 ± 0.01^{d}	5.13 ± 0.54^{be}
Y6	1266.79 ± 2.89^{f}	876.73 ± 4.79^{f}	188.16 ±3.44^{d}	358.57 ± 1.86^{e}	404.17 ± 2.10^{f}	0.9239 ± 0.02^{e}	4.07 ± 0.07^{cd}
Y7	1203.82 ± 7.84^{g}	1086.17 ± 4.64^{g}	174.56 ± 3.26^{e}	337.54 ± 3.76^{f}	439.56 ± 7.34^{e}	1.0035 ± 0.04^{b}	4.91 ± 0.32^{be}

Mean values with different superscripts in the same column show significant differences ($p < 0.05$)

Table 3. Physicochemical and microbial qualities of the 7 brands of vanilla-flavoured yoghurt

Brand of yoghurt	pH	Titratable acidity (%)	Total Soluble Sugars (°Brix)	Total Solids (%)	Viscosity (dPs)	Coliforms (10^1cfu/ml)	Yeast (10^6 cfu/ml)
Y1	4.10 ± 0.02^{a}	0.85 ± 0.05^{a}	11.36 ± 0.00^{a}	14.55 ± 0.19^{a}	1.63 ± 0.23^{a}	3.8 ± 0.09^{bc}	1.25 ± 0.02^{ab}
Y2	4.12 ± 0.00^{a}	0.93 ± 0.01^{b}	11.36 ± 0.00^{a}	15.06 ± 0.20^{b}	1.37 ± 0.32^{a}	6.0 ± 0.29^{cd}	1.33 ± 0.16^{ab}
Y3	3.92 ± 0.07^{bc}	1.23 ± 0.02^{c}	9.57 ± 0.00^{b}	13.54 ± 0.03^{c}	1.00 ± 0.00^{b}	0.0 ± 0.00^{a}	0.84 ± 0.35^{c}
Y4	4.39 ± 0.01^{d}	0.67 ± 0.01^{d}	10.57 ± 0.00^{c}	14.29 ± 0.02^{d}	1.53 ± 0.06^{a}	4.5 ± 0.47^{bc}	1.00 ± 0.00^{ac}
Y5	3.87 ± 0.03^{b}	1.25 ± 0.01^{c}	15.93 ± 0.00^{d}	19.91 ± 0.06^{e}	2.53 ± 0.30^{c}	1.5 ± 0.00^{ab}	1.37 ± 0.05^{b}
Y6	4.45 ± 0.01^{e}	0.92 ± 0.04^{b}	12.97 ± 0.00^{e}	17.75 ± 0.09^{f}	1.67 ± 0.21^{a}	9.3 ± 0.00^{d}	1.40 ± 0.39^{b}
Y7	3.95 ± 0.02^{c}	1.06 ± 0.01^{e}	11.93 ± 0.00^{f}	16.31 ± 0.14^{g}	1.50 ± 0.00^{a}	4.3 ± 0.00^{bc}	1.24 ± 0.00^{ab}

Mean values with different superscripts in the same column show significant differences ($p < 0.05$)

Table 4. Mean scores of sensory attributes of 7 brands of vanilla-flavoured yoghurts

Brand of Yoghurt	Aroma	Colour	Sourness	Sweetness	Thickness	Mouthfeel	Overall mean score
Y1	5.19 ± 1.19^{ab}	5.97 ± 0.84^{a}	5.00 ± 1.34^{ab}	5.36 ± 1.11^{ab}	5.23 ± 1.26^{a}	5.32 ± 1.11^{a}	5.34 ± 0.82^{a}
Y2	5.68 ± 1.40^{bc}	6.32 ± 0.65^{abc}	5.52 ± 0.96^{ad}	5.84 ± 0.86^{bd}	5.48 ± 1.26^{a}	5.84 ± 0.86^{ab}	5.78 ± 0.69^{b}
Y3	5.00 ± 1.69^{a}	6.16 ± 0.64^{ab}	4.32 ± 1.92^{c}	4.03 ± 1.56^{c}	4.48 ± 1.57^{b}	4.36 ± 1.85^{c}	4.73 ± 0.92^{d}
Y4	6.13 ± 0.99^{cd}	6.61 ± 0.56^{cd}	4.52 ± 1.71^{bc}	5.13 ± 1.06^{a}	6.36 ± 0.66^{d}	6.13 ± 1.03^{bd}	5.81 ± 0.58^{b}
Y5	6.16 ± 1.07^{cd}	6.52 ± 0.63^{bcd}	6.06 ± 0.85^{d}	5.94 ± 1.53^{d}	6.19 ± 1.11^{cd}	6.56 ± 0.72^{d}	6.24 ± 0.63^{c}
Y6	6.58 ± 0.67^{d}	6.74 ± 0.45^{d}	5.94 ± 1.34^{d}	6.07 ± 0.77^{d}	6.32 ± 0.83^{d}	6.23 ± 0.88^{bd}	6.31 ± 0.47^{c}
Y7	5.90 ± 1.35^{c}	6.32 ± 1.22^{abc}	6.13 ± 0.81^{d}	5.87 ± 0.92^{bd}	5.65 ± 1.08^{ac}	5.91 ± 1.14^{b}	5.96 ± 0.73^{bc}

Mean values with different superscripts in the same column show significant differences ($p < 0.05$)

yoghurt production since this enhances the growth of *Lactobacillus bulgaricus* (Ozer *et al*., 1998; Ozer and Robinson, 1999; Yeganehzad *et al.*, 2007). The total soluble sugars which influence the sweetness of the product ranged from 9.57°Brix in Y3 to 15.93ºBrix in Y5. The viscosity showed a positive correlation with both carbohydrate content and total solids (TS) of the yoghurts. Products Y7, Y6 and Y5 with higher carbohydrate content (Y7 < Y6 < Y5) had correspondingly higher total solids and viscosities, while products Y3 and Y4 with lower carbohydrate contents (Y3 < Y4) also had correspondingly and comparatively lower total solids and viscosities. This agrees with reports that higher TS improve viscosity of yoghurts (Mahdian and Mazaheri, 2007).

The Microbial loads showed significant differences between all the seven products ($p < 0.05$). The highest coliform count of 9.30×10 cfu/ml and the highest yeast counts of 1.4×10^6 cfu/ml were recorded for product Y6 (Table 3). Product Y3 had no coliforms and the counts of yeasts in it were the lowest. Both the codex standards for fermented milk products (Codex Standard 243-2003) and the Ghana Standards Board (Ghana Standard 337-2003) require that yoghurt should contain no coliforms nor yeast cells. The differences in microbial loads and other quality parameters can be attributed to differences in the handling of raw materials, the conditions for heat treatment and hygienic practices of manufacturers in the production process. It has been reported that the quality of yoghurt in local market varies from one producer to the other and that poor raw material, unhygienic practices and the type of starter culture can lead to a product of poor quality (Younus *et al.*, 2002).

The mean scores of the sensory attributes are shown in Table 4. The results indicate significant differences ($p < 0.05$) in the sensory quality of the products. The aroma and colour of all yoghurts were well appreciated by the panelists since all the scores were above 4 (neither like nor dislike). Comparatively, Y3 had the lowest score in all the other attributes and was the least acceptable product. This may be attributed to the high titratable acidity of 1.23% and low total soluble sugars of 9.57ºBrix recorded for Y3 which consequently had the lowest sugar-acid ratio of 7.78 compared to all the other products. The viscosity and thickness of yoghurt was influenced by the total solids and this was reflected in results obtained for Y3. This brand had the lowest total solids and carbohydrate content resulting in low viscosity and low consumer acceptance. In the case of Y5, the titratable acidity of 1.25% was slightly higher than that of Y3 but due to its relatively higher sugar content of 15ºBrix and greater sugar-acid ratio of 12.74, the product was relatively more acceptable to the panelist than Y3. The high sugar content possibly masked the high acidity of the product making the taste more acceptable. The brand of yoghurt labeled Y5 had the highest viscosity but not the highest mean score for thickness, which could mean that its thickness was beyond an acceptable level for the panelists. The highest overall mean score of 6.31 was scored for Y6 which also had the highest mean scores for aroma, colour and sweetness. The overall mean score was a measure of the most accepted product in terms of the sensory characteristics and the increasing order of acceptability of the products by the panelists was Y3<Y1<Y2<Y4<Y7<Y5<Y6.

Conclusion

The nutrient composition of the seven brands of yoghurt varied significantly from one another. The fat contents were generally below 1% and they could be designated as low fat or skimmed yoghurt. Products Y1, Y2, Y5 and Y7 had protein contents lower than the minimum permitted amount of 2.7% set by the Codex Standards for yoghurts. The predominant minerals in all the seven brands were calcium, phosphorus and potassium. Although product Y3 had superior microbial quality in that no coliforms were detected in it and also had the lowest yeast counts, Y3 had the lowest total solids, total soluble sugars, viscosity, energy content and eventually obtained the lowest overall sensory mean score of 4.73. The sensory analyses indicated Y6 had the highest mean scores for aroma, colour and sweetness and had the highest overall mean score of 6.31. In terms of the sensory qualities and acceptability Y6 was the most acceptable product followed by Y5.

Recommendation

Production of yoghurts marketed in Kumasi should be given more attention by manufacturers and regulatory authorities to ensure high quality products and consumer acceptability.High patronage of a product does not necessary mean that a product is of the best microbial quality.In view of the fact that microbial levels of samples were above the standards, Regulatory Bodies would have to organize training programs for manufacturers on food safety practices and also monitor intermittently the manufacturing and hygienic practices of producers.

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