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EFFECT OF EXTRUDER DIE DIMENSIONS ON THE PROPERTIES OF THE EXTRUDATE PRODUCTS

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ABSTRACT

*A modified single screw extruder (**Morcos et al. 2007**), was used in this research to study the effect of five levels of diameter/ length ratio "D/L" of the die nozzle (0.100, 0.138, 0.171, 0.208 and 0.292), two levels of fat contents (7 and 1.5%) and three levels of moisture content "MC" (10, 15, 20% of the soybean flour) on the physical and mechanical properties of the texturized soybean, beside its pH, bulk density "ρb", hardness "H", and water absorption "WA". The results showed that the best tested treatments had a D/L ratio ranged between 0.100 and 0.138, die diameter ranging between 2 and 3 mm, 20% MC and1.5% fat content.*

Keywords: Extruder, die diameter, die length, fat content, moisture content and texturized soybean

INTRODUCTION

Today, healthy food is one of the most important needs of humans. In the search for a natural alternate for meat, soybean comes first of all (***A.S.A 2002***), since it has high content of protein, which has favorable amino acids, beside containing oil and carbohydrate (***U.S.B 2004***).The first step of utilizing soybean protein is achieved by extracting most of its oil after soybean grinding. The remainder of its contents containing protein and carbohydrates is called "soy flour".

Riaz (2002) stated that, after the transformation of soybean flour by the extruder to the structured material "texturized soy bean", will have high content of protein. The ordinary used single screw extruder has lot of limitations regarding the flow of the material inside its barrel.

The operation of a single screw extruder depends on the slip of the material at its barrel wall, the degree to which the screw is filled and the

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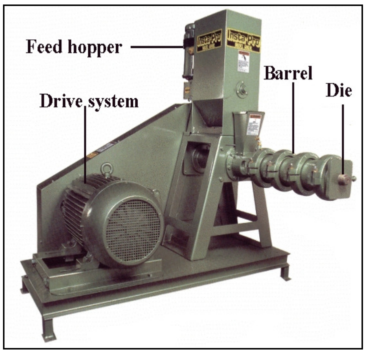
inside temperature and pressure generated during material flow.

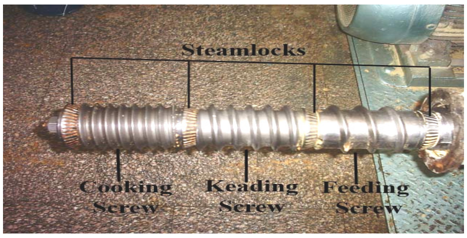
All these variables along with the type of raw ingredient limit the operation range of single screw extruders (***Mercier et al. 1989***). Also, the dimensions of the extruder die play an important role in that. The die inside nozzle diameter and length play an important role in affecting the performance of the single screw extruder (***Chinnaswamy et al. 1987***). ***Kearns et al. (2003)*** mentioned that the extrusion cooked texturized protein includes meat extenders in the form of chunks or small granular pieces which are wet milled or produced directly off the extruder. Extruders also are able to produce a meat analog that has a remarkable similarity in appearance; texture and mouth feel to meats. ***Lin et al. (2000)*** found that the soybean protein products could be texturized either at low moisture conditions (< 35%) by single screw extruders or at high moisture conditions (> 50%) using twin screw extruders. ***Singh et al. (2007)*** conducted a study to investigate the effect of feed moisture (18–24%), extrusion temperature (130–170 C) and level of pea grits (0–30%) on the extrusion behavior and extrudate properties of grain grits. The extruder die pressure decreased with the increase in moisture content and temperature. Addition of pea grits to the rice grits resulted in a decrease in die pressure in all the blends during extrusion. The expansion ratio was found to be highest at 150 ºC.

The objective of this study was to investigate the effect of die nozzle dimensions, fat contents and moisture content of the soybean flour on the physical and mechanical properties of the texturized soybean.

MATERIALS AND METHODS

A modified single screw extruder (Fig. 1) (***Morcos et al. 2007***), was used in this research to study the effect of die dimensions on the properties of the locally produced texturized soybean. The performance of the extruder depends upon the increase of the pressure imposed by the extruder on soybean flour accompanied by the increase of temperature generated by the dissipated energy during the flow of soybean material inside the extruder along its three consecutive zones.





A developed extruder's screw.

Fig. (1): The used single screw extruder.

Treatments:

1. Die dimensions

The dimensions of the used five extruder dies are shown in table (1).

Table (1): Dimensions of different dies used in the experiments

Die No.	Die dimensions		D/L ratio
	Length, mm	Inside diameter, mm	
1.	30.0	3.0	0.100
2.	14.5	2.0	0.138
3.	17.5	3.0	0.171
4.	13.0	2.7	0.208
5.	13.7	4.0	0.292

2. Fat content

The tested values of fat contents were: 7 and 1.5% (by weight).

3. Moisture content "*MC*"

Three different values of soybean flour moisture content were tested: 10, 15 and 20%.

Fig. (2) demonstrates the studied treatments.

Calculation and Laboratory Measurements

1. Moisture content, crude protein, fat, total carbohydrates and ash contents were determined according to the methods described in ***A.O.A.C (1995)***.
2. The pH of soybean flour was determined using pH meter, following the methods described in ***Ranganna (1977)***.

Treatment symbol	D/L ratio 0.100	D/L ratio 0.138	D/L ratio 0.171	D/L ratio 0.208	D/L ratio 0.292	Moisture content 10%	Moisture content 15%	Moisture content 20%
A	*					*		
B	*						*	
C	*							*
D		*				*		
E		*					*	
F		*						*
G			*			*		
H			*				*	
I			*					*
J				*		*		
K				*			*	
L				*				*
M					*	*		
N					*		*	
O					*			*

For fat content 7%, the symbols have a subscript "1"
For fat content 1.5%, the symbols have a subscript "2"

Fig. (2): The symbols of the tested treatments.

3. The bulk density was calculated from equation (1):

$$\rho\ b = 10^3 \times \frac{m}{V} \quad \text{.............(1)}$$

where:

ρ_b = The bulk density of the produced texturized soybean, g /l;
m = The mass of the texturized soybean, g;
V = The volume of the texturized soybean, cm^3.

4. The texturized soybean hardness "*H*" was determined using a digital hardness measuring instrument.

It has to be mentioned here that the "hardness" in food technology is measured in (Newtons) which means the force under which the aggregates collapse.

5. Water absorption capacity "*WA*" was measured following the method described by ***(A.A.C.C. 1995)***.
6. Aggregate size distribution
   A set of sieves of 9.5, 3.35, 2 and 1.4 mm diameter were used. The mean weight diameter of the aggregates was calculated according to ***De-Leenheer and De-Boodt (1966)***.

RESULTS AND DISCUSSION

1- Chemical components of texturized soybean

The chemical components of the imported and the locally produced texturized soybean are shown in table (2).

Table (2): Chemical components of the imported and the locally produced texturized soybean.

	Fat %	Protein %	Total Carbohydrates %	Ash %	Moisture %
Imported texturized soybean	0.5	67.5	19.5	6.6	5.9
Locally produced texturized soybean	7	47.1	29.8	7.3	8.8
Average values for 1.5% fat content treatments	1.5	55	28.1	7.2	8.2
Average values for 7% fat content treatments	7	51.8	27.9	7.1	6.2

Comparing the results of the imported and the locally produced texturized soybean, it was found that the protein of the locally produced texturized soybean was less than that of the imported one by 20.4%. Also, fat content, total carbohydrates, ash and moisture content of the locally produced texturized soybean were more than those of the imported one by 6.5%, 0.32%, and 0.7and 2.9% respectively.

2. Texturized soybean pH

The average values of the texturized soybean pH are shown in table (3) and Fig. (3). It is clear that the pH of the imported texturized soybean were less by 2 than that of the normally produced texturized soybean.

TAble (3): Physical properties of the texturized soybean at 7% and 1.5% fat content for different treatments

Treatment symbol	*D/L* ratio	*MC*, %	pH		Bulk density, g/l		Hardness, N		Water absorption, %	
			7%*	1.5%**	7%*	1.5%**	7%*	1.5%**	7%*	1.5%**
A	**0.100**	**10**	7.8	7.1	405	333	13.2	18.1	317.1	365.2
B	**0.100**	**15**	7.8	7.0	402	326	15.4	21.4	318.6	360.1
C	**0.100**	**20**	7.9	6.8	392	310	17.1	22.6	319.2	373.0
D	**0.138**	**10**	7.8	7.2	410	336	12.9	17.2	310.3	372.2
E	**0.138**	**15**	8.0	7.1	402	330	13.1	18.2	313.3	368.6
F	**0.138**	**20**	7.8	7.1	400	320	13.6	18.6	316.4	365.0
G	**0.171**	**10**	8.3	7.3	422	345	12.9	16.4	306.3	362.8
H	**0.171**	**15**	8.2	7.2	420	344	13.0	17.4	307.2	355.0
I	**0.171**	**20**	8.1	7.2	408	334	13.6	17.9	308.4	360.4
J	**0.208**	**10**	8.3	7.3	435	356	12.1	16.9	306.5	362.1
K	**0.208**	**15**	8.3	7.2	425	348	12.2	17.0	307.8	362.1
L	**0.208**	**20**	8.1	7.2	421	340	12.2	17.1	307.8	360.6
M	**0.292**	**10**	8.3	7.4	446	356	12.4	15.9	292.9	352.4
N	**0.292**	**15**	8.3	7.2	440	360	13.6	15.8	297.7	350.2
O	**0.292**	**20**	8.3	7.2	432	354	13.9	16.3	299.5	344.6
Imported texturized			6.7		321.0		18.7		400.7	
Locally produced texturized			8.7		485.0		11.6		265.0	

* For fat content 7%, the symbols have a subscript "1"
** For fat content 1.5%, the symbols have a subscript "2"

Also, the values of pH for all treatments at the two levels of fat (7% and 1.5%) were more than that of the imported texturized soybean, but the values of pH for the treatments at 1.5% fat were less than those of the treatments at 7% fat, and more close to that of the imported texturized soybean.

At 7% fat content, the pH values increased by 6.4% when the ratio of die diameter/length (*D/L* ratio) increased from 0.100 (Treatment A_1) to 0.929 (Treatment M_1). The same trend was found at 15 and 20% moisture contents. At 1.5% fat content, the pH values decreased by decreasing *D/L* ratio and by increasing moisture content.

From Fig. (3), it could be concluded that the C_2 treatment is the best treatment at 1.5% fat content and 20% moisture content. However, this treatment could give less productive rate since the die diameter is 3.0 mm while that of M_1 is 4.0 mm.

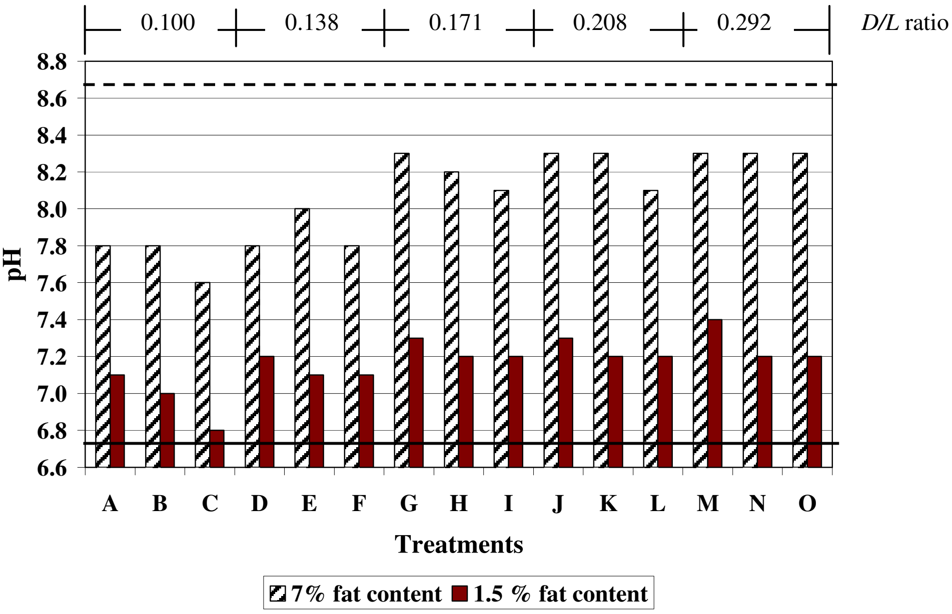
3. The bulk density "ρb" of the texturized soybean

The average values of texturized soybean bulk density "ρb" are shown in table (3) and Fig. (4). It is clear that the ρb of the imported texturized soybean was less by 164 g/l than that of the locally normally produced texturized soybean.

The ρb values of the different treatments increased by increasing the *D/L* ratio and by decreasing the moisture content The values of ρb for all treatments at the two levels of fat (7% and 1.5%) were greater than that of the imported texturized soybean, but the value of ρb of the treatment C_2 (*D/L* ratio = 0.100, *MC* = 20% and fat content = 1.5%) was less than that of the imported texturized soybean. However, the value of bulk density for the treatment F_2 at 1.5% fat content was almost the same as that of the imported texturized soybean.

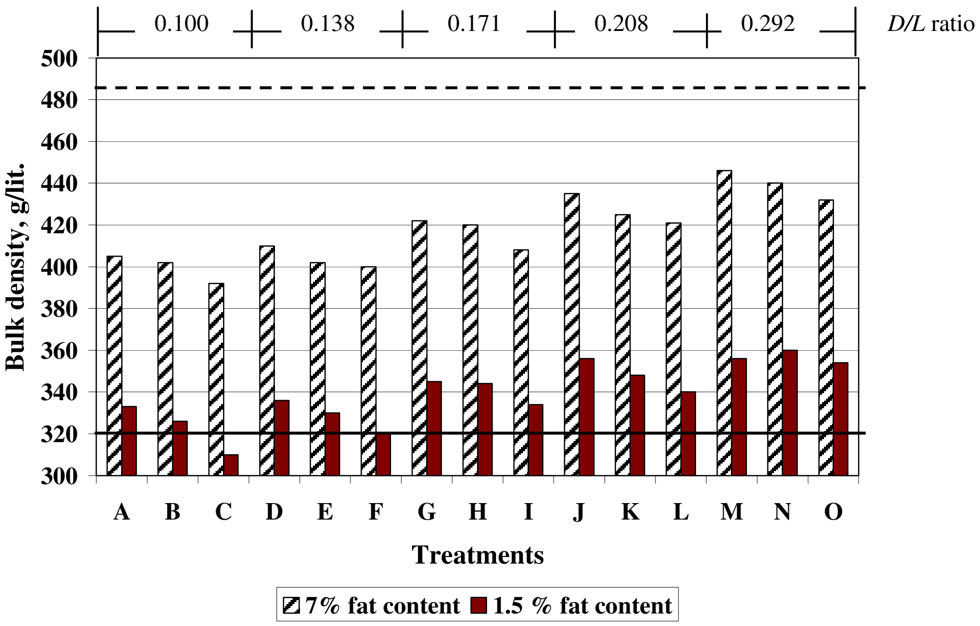
At 7% fat content, the ρb value was increased by 10.12 % when the die diameter/length "*D/L* ratio" increased from 0.100 (treatment A_1) to 0.929 (Treatment M_1) at 10% moisture content. The same trend was found at 15 and 20% moisture contents.

Fig. (4) showed that the F_2 and C_2 treatments at 1.5% fat content and 20% moisture content were the best treatments. However, the production rate of this treatment is expected to be less than the treatments "M_2, N_2 and O_2" since the die diameter of the first was only 2 mm, while that of the last treatments was 4mm.



Imported texturized soybean — locally produced texturized soybean

Fig. (3): Effect of the tested treatments on the pH of the texturized soybean.



Imported texturized soybean — locally produced texturized soybean

Fig. (4): Effect of the tested treatments on the bulk density of the texturized soybean

The value of ρb for the treatment C_2 at the 1.5% fat content was less than the imported texturized soybean. This was due to that its aggregate size tends to be bigger than that of the imported texturized soybean. This caused an increase in its inter aggregates spaces, which resulted in the lower value of its bulk density. The productive rate for this treatment is expected to be higher than that of treatment F_2 since the die diameter of the first treatment was 3mm, while that of the later was only 2mm.

Multiple regression analysis was used to derive a regression equation (2), expressing the effects of die diameter/ length ratio "*D/L*" and material moisture content "*MC*" on the bulk density "ρb" of the texturized soybean at 1.5 %fat content.

$$\rho b = a_1.(D/L) + b_1.MC + k_1 \ldots\ldots\ldots\ldots\ldots (2)$$

where

ρb = Texturized soybean bulk density, g/l;
D/L = Die diameter/ length ratio, dimensionless; $(0.100 \le D/L \le 0.292)$
MC = Moisture content , %; $(10 \le MC \le 20)$
a_1, b_1 & k_1 = Empirical constants.
$a_1 = 181.96$, $b_1 = - 1.36$, $k_1 = 326.786$, $R^2 = 0.896$

Also, the effect of die diameter/ length ratio "*D/L*" and moisture content "*MC*" on the texturized soybean bulk density "ρb" was highly significant at 0.01 level of probability, i.e. the ρb is highly affected by these two studied factors.

3. The hardness "*H*" of the texturized soybean

The average values of the texturized soybean hardness "*H*" are shown in table (3) and Fig. (5). It is clear that the *H* value of the imported texturized soybean was greater by 7.1 N than that of the locally normally produced texturized soybean.

The *H* values of the tested treatments decreased by increasing the *D/L* ratio and by increasing the moisture content. The values of *H* for all treatments at 7% and 1.5% fat content were less than that of the imported texturized soybean except for treatments B_2 and C_2 since its values increased than that of the imported texturized soybean by 9 % and 15.5% respectively. For treatments F_2 E_2 and A_2, the *H* value decreased only by

0.5 %, 2.7% and 3.2% respectively than that of the imported one, while the reduction in *H* value for the rest treatments at the 1.5% fat content ranged between 4.3% and 15.5 %.

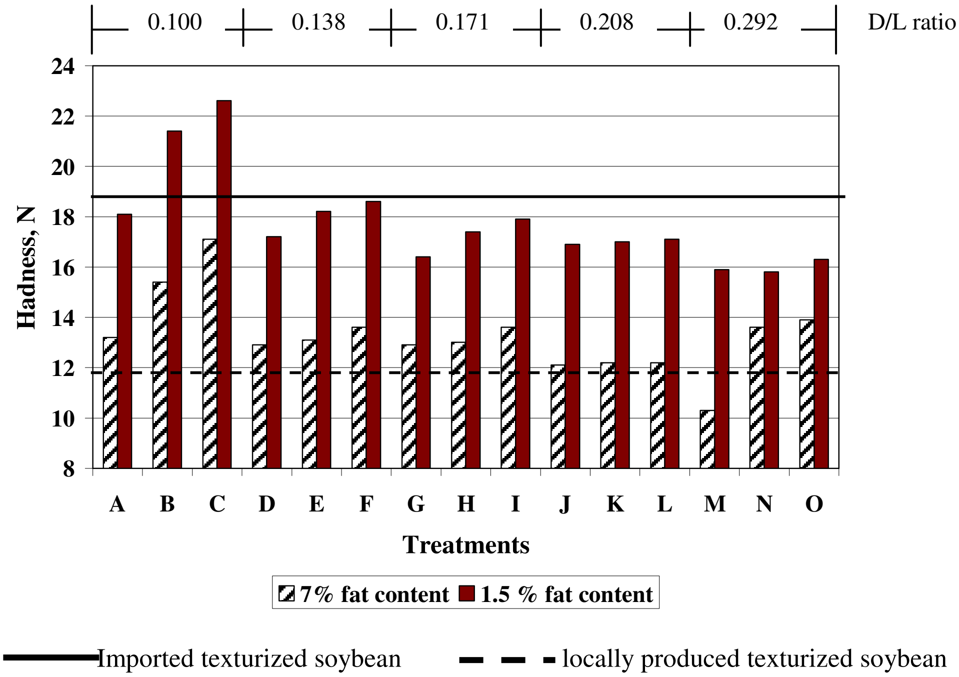


Fig. (5): Effect of the tested treatments on the hardness of the texturized soybean

It has to be mentioned here that both the bulk density and the hardness values for treatment C_2 were better than those of the imported one, which means that the C_2 treatment gave better stability for the aggregates and better product.

The best followed ones are for treatments F_2, E_2 and I_2. For the C_2, B_2 and I_2 treatments, it is expected to give better production rates than those of E_2 and F_2, since the die diameter was 3mm for the first, while it was only 2.0 mm for the later.

Multiple regression analysis was used to derive a regression equation (3), expressing the effects of die diameter/ length ratio "*D/L*" and material moisture content "*MC*" on the hardness "*H*" of the texturized soybean at 1.5 %fat content.

$$H= a_2.(D/L) + b_2.MC+ k_2 \ldots\ldots\ldots\ldots\ldots(3)$$

where

H = Texturized soybean hardness, N;

D/L = Die diameter/ length ratio, dimensionless; $(0.100 \le D/L \le 0.292)$

MC = Moisture content , %; $(10 \le MC \le 20)$

a_2, b_2 & k_2 = Empirical constants.

$a_2 = -22.072$, $b_2 = 0.17$, $k_2 = 19.2293$, $R^2 = 0.73$

Also, the effect of die diameter/ length ratio "*D/L*" and moisture content "*MC*" on the texturized soybean hardness "*H*" was highly significant at 0.01 level of probability, i.e. the *H* is highly affected by these two studied factors.

4. The water absorption "*WA*" of the texturized soybean

The average values of the texturized soybean water absorption "*WA*" are shown in table (3) and Fig. (6). It is clear that the *WA* of the imported texturized soybean were greater by 135.7% than that of the locally normally produced texturized soybean.

The *WA* values for the tested treatments were varying by increasing the *D/L* ratio and by increasing the moisture content. The values of *WA* for all treatments at the two levels of fat (7% and 1.5%) were less than that of the imported texturized soybean. But for the 1.5% fat content, the values of *WA* increased than those of 7% fat content within a range of 41% up to 62%. The best result was obtained for treatment C_2 (375.0 %) followed by treatments D_2, E_2, A_2 and F_2, since their values for WA were 372.0 %, 368.6%, 365.25 and 365.0% respectively. However, the productive rates for both treatments C_2 and A_2 are expected to be greater than those of D2, E2 and F2, since the die diameter for the first treatments was 3.0 mm while that of the later was only 2.0 mm.

Multiple regression analysis was used to derive a regression equation (4), expressing the effects of die diameter/ length ratio "*D/L*" and material moisture content "*MC*" on water absorption "*WA*" of the texturized soybean at 1.5 %fat content.

$$WA = a_3.(D/L) + b_3.MC + k_3 \quad \ldots\ldots\ldots\ldots\ldots(4)$$

where

WA = Texturized soybean water absorption, %;

D/L = Die diameter/ length ratio, dimensionless; $(0.100 \le D/L \le 0.292)$

MC = Moisture content , %; $(10 \le MC \le 20)$

a_3, b_3 & k_3 = Empirical constants.

$a_3 = -94.268$, $b_3 = -0.222$, $k_3 = 381.42$, $R^2 = 0.68$

Also, the effect of die diameter/ length ratio "*D/L*" and moisture content "*MC*" on the texturized soybean water absorption "*WA*" was highly significant at 0.01 level of probability, i.e. the *WA* is highly affected by these two studied factors.

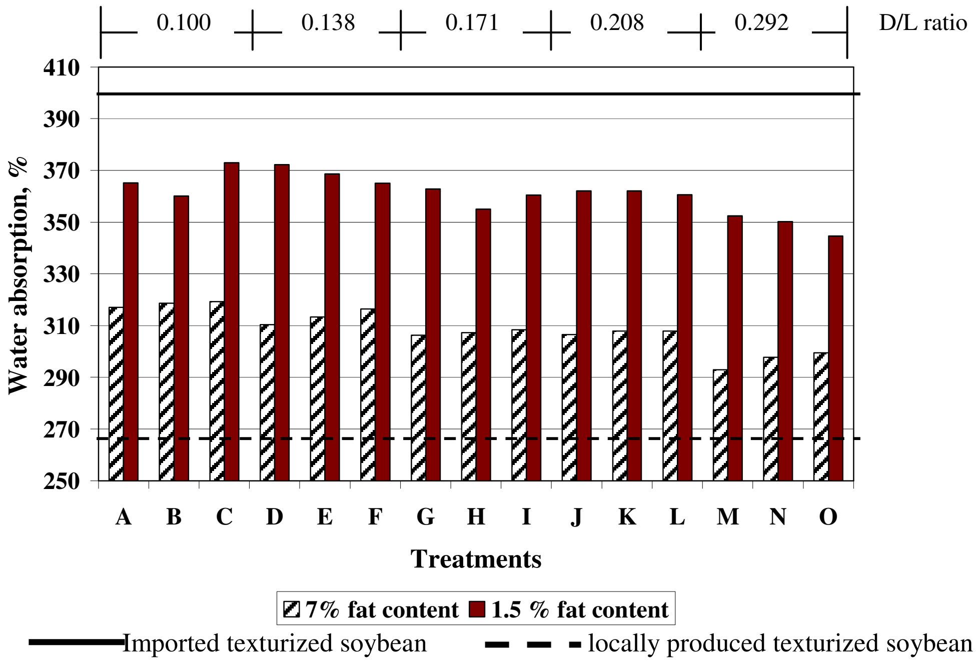


Fig. (6): Effect of the tested treatments on the water absorption of the texturized soybean

5- The aggregate sizes of texturized soybean

The distributions of the aggregate sizes for all the tested treatments and that for the imported and the locally produced texturized soybean are shown in table (4).

Table (4) shows that all the tested treatments at 1.5% fat content have higher percentages for the accepted aggregates "more than or equal to 2mm" (≥ 2mm) compared with those of the imported one, while only five treatments at 7% fat content have higher percentage than those of the imported one, which were treatments F_1, H_1, L_1, K_1 and E_1.

Table (4): The percentage of the texturized soybean aggregate size and mean weight diameter for all treatments.

Treatment symbol	D/L ratio	MC %	≥ 9.5 mm		< 9.5- 3.35 mm		< 3.35 - 2.0 mm		∑ ≥ 2 mm		<2 - 1.4 mm		<1.4 mm		∑ < 2 mm		Mean diameter, mm	
			7%	1.5%	7%	1.5%	7%	1.5%	7%	1.5%	7%	1.5%	7%	1.5%	7%	1.5%	7%	1.5%
A	**0.100**	**10**	4.2	4.6	33.1	40.9	46.4	44.1	83.7	89.6	8.4	4.6	7.9	5.8	16.3	10.4	4.0	4.4
B	**0.100**	**15**	3.6	6.1	34.2	40.6	46.6	45.9	84.4	92.6	8.5	5.1	7.1	2.3	15.6	7.4	4.1	4.5
C	**0.100**	**20**	8.1	5.1	32.8	49.3	43.1	38.1	84.0	92.5	7.4	4.9	8.6	2.6	16.0	7.5	4.3	4.8
D	**0.138**	**10**	3.1	4.6	30.6	35.6	50.4	52.0	84.1	92.2	8.3	4.9	7.6	2.9	15.9	7.8	3.9	4.2
E	**0.138**	**15**	2.0	5.9	31.2	40.5	52.7	45.6	85.9	92.0	9.8	5.0	4.3	3.0	14.1	8.0	3.8	4.5
F	**0.138**	**20**	5.7	5.3	32.7	45.1	49.1	41.5	87.5	91.9	9.2	4.6	3.3	3.5	12.5	8.1	4.2	4.6
G	**0.171**	**10**	0.0	3.9	30.6	35.2	53.1	52.8	83.7	91.9	8.6	6.1	7.7	2.0	16.3	8.1	3.7	4.2
H	**0.171**	**15**	1.4	4.9	28.4	38.4	57.2	47.1	87.0	90.4	7.9	7.3	5.1	2.3	13.0	9.6	3.7	4.4
I	**0.171**	**20**	0.0	5.2	33.3	41.6	50.9	46.7	84.2	93.5	8.9	4.6	6.9	1.9	15.8	6.5	3.8	4.5
J	**0.208**	**10**	0.5	2.8	28.9	34.5	52.0	56.5	81.4	93.8	10.9	2.8	7.7	3.5	18.6	6.2	3.6	4.1
K	**0.208**	**15**	0.0	3.7	30.5	34.4	55.5	57.5	86.0	95.6	9.7	3.1	4.3	1.4	14.0	4.4	3.7	4.2
L	**0.208**	**20**	1.2	3.1	29.7	39.6	55.7	52.8	86.6	95.5	8.2	2.9	5.2	1.6	13.4	4.5	3.7	4.3
M	**0.292**	**10**	0.0	1.4	30.6	34.9	52.4	54.3	83.0	90.6	8.8	4.7	8.2	4.7	17.0	9.4	3.7	4.0
N	**0.292**	**15**	0.0	1.5	30.8	36.4	52.2	55.4	83.0	93.3	9.9	3.1	7.1	3.6	17.0	6.7	3.7	4.1
O	**0.292**	**20**	0.0	2.4	32.6	35.1	50.8	55.9	83.4	93.4	7.4	4.2	9.2	2.4	16.6	6.6	3.7	4.1
Imported			0.0		36.6		48.2		84.8		7.6		7.6		15.2		3.9	
Locally produced			0.0		33.6		21.2		54.8		14.4		30.8		45.2		3.4	

For the unacceptable sizes less than 2 mm, all the tested treatments at 1.5% fat content have less percentage than that of the imported one, while only five treatments at the 7% fat content had less values than that of the imported one, treatments E_1, K_1, L_1, H_1 and F_1.

Table (4) also shows that all of the tested treatments at 1.5% fat content have higher value for the mean diameters of the aggregates compared with that of the imported one, while only five treatments at the 7% fat content have bigger values, which were treatments C_1, F_1, B_1, A_1 and D_1.

CONCLUSION

From this investigation, the following conclusion can be made:

1. The protein of the locally produced texturized soybean was less than that of the imported one by 20.4%.
2. According to the pH values, the C_2 treatment (die diameter/ length ratio = 0.100) is the best treatment at 1.5% fat content and 20% moisture content.
3. According to the bulk density values, the F_2 (die diameter/ length ratio = 0.138) and C_2 treatments at 1.5% fat content and 20% moisture content were the best treatments.
4. According to the hardness values, the C_2 treatment was the best treatments.
5. According to the water absorption values, the C_2 treatment was the best treatments.
6. For the unacceptable sizes less than 2 mm, all the tested treatments at 1.5% fat content have less percentage than that of the imported one.

The best tested treatments had a *D/L* ratio ranged between 0.100 and 0.138, die diameter ranging between 2 and 3 mm, *MC* of 20% and fat content 1.5%.

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<u>**الملخص العربي**</u>

تأثير أبعاد فتحة الخروج للباثق الحراري علي خواص المنتجات المبثوقة

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يهدف هذا البحث الي دراسة تأثير خمس مستويات للنسبة بين قطر/ طول فتحة الخروج للباثق الحراري احادي الحلزون (0.100، 0.138، 0.171، 0.208، 0.292)، مستويين لمحتوي الدهن (7، 1.5%) لدقيق الصويا، ثلاث مستويات للمحتوي الرطوبي (10، 15، 20%) لدقيق الصويا علي خواص اضافات اللحوم المصنعه محلياً من حيث (pH، الكثافة الظاهرية، الصلابة، قوة امتصاص الماء والاحتفاظ به، حجم الحبيبات) لتقارب خواص تلك الاضافات المستوردة، مما يؤدي الى تحسين جودة اللحوم المصنعة لتناسب ذوق المستهلك.

وقد تم إستخدام الباثق الحراري احادي الحلزون المطور ***(Morcos et al. 2007)***

وقد بينت الدراسة مايلي :

1. تقل نسبة البروتين في إضافات اللحوم المنتجة محلياً من دقيق الصويا عن مثيلاتها المستوردة بنسبة 20.4%.
2. حققت المعاملة C_2 (نسبة قطر / طول فتحة الخروج = 0.100) عند محتوي دهن 1.5% ومحتوي رطوبي 20% أفضل قيمة من حيث pH حيث كانت 6.8 بينما كانت للمنتج المستورد 6.7.
3. حققت المعاملة F_2 (نسبة قطر / طول فتحة الخروج = 0.138، محتوي دهن 1.5%، محتوي رطوبي 20%) أفضل قيمة للكثافة الظاهرية حيث كانت 320 جم/ لتر بينما كانت للمنتج المستورد 321 جم/ لتر وتفوقت المعاملة C_2 عن المنتج المستورد حيث إنخفضت الكثافة الظاهرية للمنتج عندها الي 310 جم/ لتر.
4. حققت كل المعاملات عند نسبة قطر / طول فتحة الخروج تراوح مابين 0.100إلي 0.138 محتوي دهن 1.5% أفضل قيمة لصلابة الحبيبات مقارنة بالمنتج المستورد وكانت اكبر قيمة للصلابة عند المعاملة C_2 التي كانت عندها 22.6 نيوتن.
5. حققت المعاملة C_2 أفضل قيمة لامتصاص الماء حيث كانت 373% بينما للمنتج المستورد 400.7%.
6. بالنسبة لقطر الحبيبات المفضل وهو اكبر من 2 مم فقد حققت كل المعاملات عند محتوي دهن 1.5% قيم تفوقت علي المنتج المستورد.

ونستخلص من ذلك ان إستخدام نسبة قطر / طول فتحة الخروج تراوح مابين 0.100إلي 0.138، وقطر فتحة الخروج تراوح مابين 2إلي 3مم، ومحتوي دهن 1.5% ، و محتوي رطوبي 20% يحقق أفضل مواصفات لاضافات اللحوم المنتجة محلياً.

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