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Formulation And Texture Analysis of Environment Friendly Zein Gum

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ABSTRACT

Zein is a natural product,both edible and biodegradable.Zein has been developed into elastomeric compound which are usefull as structural material for fabrication of edible film.Physical and rheological property of zein suggest its application as chewing gum base.Syenthetic chewing gum base has property to stick to surfaces,because of its adhesive texture,and gum long lasting nature it is very difficult to clean off surfaces.The high cost associated with chewing gum waste management add up millions of dollar worldwide.Many researchers have investigated possibility of developing gum products that are biodegradable or less sticky in an attempt to remove these problem.In current study model corn zein gum is developed and effect of formulation components on textural properties was investigated.

Key words: Corn zein, texture, gumbase, chewing gum, biodegradable.

INTRODUCTION

Zein is a protein biopolymer that is renewable and can be extracted from corn and corn coproducts. The ability for zein to be renewable is important now that other synthetic polymers are tied to increasing prices in oil. Important characteristics of zein is its inherent water insolubility and ability to be plasticized and cross-linked, which can impart desired flexibility, strength, toughness, permeation resistance, and solvent insolubility. There has also been renewed work improving the purity and functionality of zein for new applications. The ability to produce decolorized and deodorized zein has allowed the application of extremely pure zein in the medical field for tissue technology and cell growth. Other new uses have been in the packaging field, various food applications, and also producing spheres that can bind drugs and other labile compounds .

Zein has had a variety of applications: plastics[1], coatings[2],inks[3],chewing gum[4], adhesives, and fibers[5], etc.During the 1950's when synthetic material become cheaper, zein products were not cost-effective and lost use. Today zein is used for food and pharmaceutical coatings[6]. Being mostly nonpolar in nature, zein films have been explored for coatings in numerous food applications. Rakotonirainy et. al [7] used three-ply pressed oleic acid zein resin sheets laminated with tung oil for broccoli preservation. Both the zein film and polyethylene films allowed retention of broccoli firmness and color after six days in refrigerated storage; broccoli in zein-only films lacked off-smells. Zein was also used to help preserve the integrity of a turkey product[8] . The turkey was dusted with zein and soy protein isolate before frying. Zein's film-forming properties were credited for helping reduce the uptake of oil. Zein coatings have even been considered as a means to control undesirable seed germination. Broccoli and sugar beet seeds germinated later and more slowly when dressed with a light zein coating[9].Zein is also used for the preparation of cosmetic powders[10-11] and for a delivery system for acid sensitive drugs.[12-13].

MATERIALS AND METHODS

2.1. Ingredients for preparation of gum sample

Different formulations of corn zein chewing gum sample were included in the study, which varied in the plasticizer used. The corn zein gum formulations used Palmitic acid, Myristic acid, Stearic acid , Acetamide, Acetanalide, Urea, Triethanolamine,Diethanolamine,Glyceryl monooleate and Glyceryl monostearate as plasticizer. Other than the plasticizer, all of the ingredients and the amounts of each ingredient were the same for each formulation.

The ingredients used in making each of the corn zein chewing gums consisted of corn zein (regular grade M. P. Biomedical,LLC), ethanol (C.D.H. New Delhi), Sodium dodecyl sulphate (Estelle Pvt Limited), partially hydrogenated palm oil (Krishna Oil extraction limited, pachor, Rajgarh, M.P.), artificial cinnamon flavor (GLEE Gum kit U.S.A.), Palmitic acid, Myristic acid, Stearic acid , Acetamide, Acetanalide, Urea, Triethanolamine,Diethanolamine,Glyceryl monooleate and Glyceryl monostearate (C.D.H. New Delhi)

Corn zein is a food-grade protein, and all the other ingredients used in the gum formulation for this study were also food-grade quality. Table 1 shows a summary of the corn zein gum formulation.

Table 1: Summary of the Corn Zein gum formulation.(MCG1-MCG-10)

S.No	Ingredient(%w/w)	MCG 1	MCG 2	MCG 3	MCG 4	MCG 5	MCG 6	MCG 7	MCG 8	MCG9	MCG 10
1	Corn Zein	50	50	50	50	50	50	50	50	50	50
2	Sodiumdodecyl sulphate	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
3	Palm Oil Partially Hydrogenated	8	8	8	8	8	8	8	8	8	8
4	Plasticizer	A 70	E 70	F 70	G 70	H 70	D 70	B 70	C 70	I 70	J 70
5	Sorbitol Solution	50	50	50	50	50	50	50	50	50	50
6	Filler Photoactive Titanium dioxide	5	5	5	5	5	5	5	5	5	5

Corn zein gum was made either with (A) Palmitic acid, (B) Myristic acid (C) Stearic acid , (D) Acetamide, (E) Acetanalide, (F) Urea, (G) Triethanolamine,(H) Diethanolamine, (I) Glyceryl monooleate and (J) Glyceryl monostearate
The exact amounts of each ingredient for the are summarized in Table 1.

2.2. Method for making corn zein chewing gum samples

Laboratory sigma blade mixer with front to rear speed ratio of 2:1 was used for formulation of Corn Zein chewing gum.Aqueous ethanolic solution of zein powder was poured in sigma blade mixer ,all the ingredients except hydrogenated soybean oil and flavor were added and mixed in sigma blade mixer for ten minutes.Sigma blade mixer had a temperature control device which maintains temperature intermittently until it reached 50 degrees Celsius. The special (z) shape of blade present in sigma blender helped in complete mixing and produce heat which evaporated the ethanol present in the solution.To prevent exposure of heat partially hydrogenated vegetable oil was added to sigma blender.[14] The corn zein solution was poured into the container which had five liters of purified ice water having its temperature maintained at three degree Celsius.The cold water caused zein to precipitate from ethanol solution.A dough like consistency was formed and zein particles were able to aggregate together and entrap rest of the ingredients.The dough was kneaded and rinsed in containers of purified water for two times, 10 min each to form a flexible gum base. The kneading action of sigma blade blender further blended the ingredients and rinsed away any remaining ethanol. The gum base was then spread into a thin sheet with a roller and cut into strips of 5 g each. Each strip was approximately 4 cm long, 1 cm wide, and 2 mm thick. All the gum samples were stored at room temperature

2.3. Method for coating corn Zein formulations

Coating of MCG was done by liquid coating solution of sorbitol & glycerin. This mixture was heated at 60 degree Celsius for 15 min and allowed to mix uniformly. Gum pieces were dipped in the solution (Accasia 2%w/v), and after a specified time interval of 1 min, (to allow the liquid to spread evenly over the piece), a dry powder material (Sorbitol) was applied. This helps to dry the liquid coating; this is referred to as Dry Charging & is commonly used in soft panning operation. This was applied in about 3 to 12 dry charge application. After a dry charge 2 to 4 liquid

applications are made to cover dry charge material, then the coating was dried in the hot warm air in the temperature range 27 ^{0}C to 38 ^{0}C.Table 2 shows concentration of five coating solution.

Table 2: Concentration of coating solutions

S.no	Ingredients	Coating 1	Coating 2	Coating 3
1.	Gum base	25	25	25
2.	Accasia (%w/v)	1	2	3
3.	Glycerin	6	6	6
4.	Sorbitol	15	14	13
5.	Flavor	3	3	3

2.4 Charectarization of corn zein gum

2.4.1 Texture profile analysis (TPA): Texture profile analysis (TPA) is an objective method of sensory analysis of compressing standard-sized samples of food twice. The test consists of compressing a bite-size piece of food two times in a reciprocating motion that imitates the action of the jaw and from the resulting force-time curve a number of textural parameters can be calculated, that correlate well with sensory evaluation.TPA is used to determine the firmness and adhesiveness for coating solution of corn zein gum.

The parameters derived from TPA test are as follows.

A) Hardness-Hardness is defined as the maximum peak force during the first compression cycle (first bite) and often been substituted by term firmness.

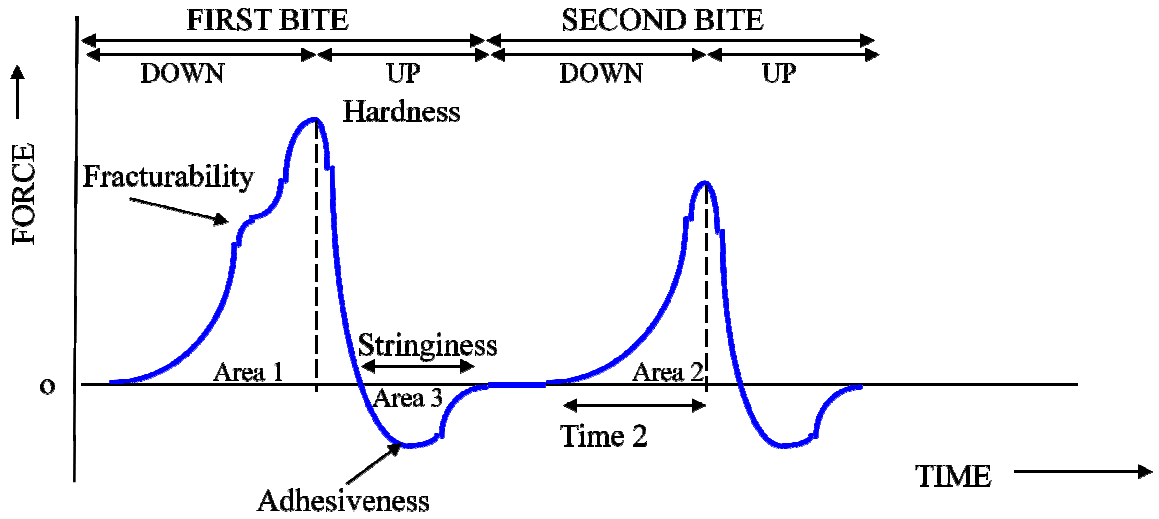

Fig 1: Texture profile analysis (TPA) graph showing various TPA parameters

Cohesiveness = area 2/area 1
Springiness = time2/time1
Gumminess = hardness x cohesiveness
Chewiness = gumminess x springiness

B) Fracturability (Originally called brittelness) is defined as the force at the first significant break in the TPA curve.

C) Adhesiveness –Adhesiveness is defined as a negative force area for the first bite and represent the work required to overcome the attractive forces between the surface of the food and the surface of the other material with which the food comes into contact,i.e. the total force necessary to pull the compression plunger away from the sample.

Observations-Coating firmness and adhesiveness of corn zein formulation (MCG-1 to MCG-10) is summarized in (Table 3-5) and (Figure 2-14).Coating 1 solutions which comprises of accasia 1%w/v,was reported with average coating firmness of 1.035kg and adhesiveness of (-0.091Kg),coating solution 3 which comprises of accasia 3%w/v,was reported with average coating firmness of 1.304kg and adhesiveness of (-0.129Kg),and coating 2 solutions which comprises of accasia 2%w/v,was reported with average coating firmness of 1.182kg and adhesiveness of (-0.113Kg), which is similar to values obtained with reference marketed preparations (Nicotine Polacrilex gum,Manufactured at Zenara Pharma private limited,Hyderabad and marketed by Johnson & Johnson Limited).TA setting are described below ,which were used for determination of firmness (Mean maximum positive force and adhesiveness (Mean maximum negative force).

Texture Analysis (TA) Settings
Sequence Title: Return to Start (Set Dist)
Test Mode: Compression
Pre-Test Speed: 1 mm/sec
Test Speed: 2.0 mm/sec
Post-Test Speed: 10.0 mm/sec
Target Mode: Distance
Force: 200gm
Distance: 5 mm
Strain:10%
Trigger Type:Auto (Force)
Trigger Force: 5.0 g
Stop Plot At: Start Position
Probe:P/3;3mm Dia Stainless steel cylinder
Points per second: 200

Table 3:Firmness obtained by coating 1.

Test ID	Batch		Firmness in Kilograms Kg	Adhesiveness in Kilograms Kg
Start Batch 1	1			
Firmness by penetration of corn zein gum,MCG-1	1		1.716	-0.035
Firmness by penetration of corn zein gum,MCG-2	1		1.250	-0.080
Firmness by penetration of corn zein gum,MCG-3	1		1.061	-0.145
Firmness by penetration of corn zein gum,MCG-4	1		0.922	-0.126
Firmness by penetration of corn zein gum,MCG-5	1		0.589	-0.079
Firmness by penetration of corn zein gum,MCG-6	1		1.428	-0.073
Firmness by penetration of corn zein gu ,MCG-7	1		0.826	-0.098
Firmness by penetration of corn zein gum,MCG-8	1		0.832	-0.079
Firmness by penetration of corn zein gum,MCG-9	1		0.822	-0.112
Firmness by penetration of cornzeingum,MCG-10	1		0.860	-0.080
Average:	1(F)		1.035	-0.091
S.D.	1(F)		0.350	0.031
Coef.of variation	1(F)	STDEV("BATCH")/AVERAGE ("BATCH")*100	33.794	-34.189

Table 4 :Firmness obtained by coating 2.

Test ID	Batch		Firmness in Kilograms Kg	Adhesiveness in Kilograms Kg
Start Batch 1	1			
Firmness by penetration of corn zein gum,MCG-1	1		0.916	-0.043
Firmness by penetration of corn zein gum,MCG-2	1		0.920	-0.133
Firmness by penetration of corn zein gum,MCG-3	1		1.076	-0.163
Firmness by penetration of corn zein gum,MCG-4	1		1.194	-0.127
Firmness by penetration of corn zein gum,MCG-5	1		0.757	-0.056
Firmness by penetration of corn zein gum,MCG-6	1		0.954	-0.151
Firmness by penetration of corn zein gu ,MCG-7	1		2.333	-0.078
Firmness by penetration of corn zein gum,MCG-8	1		1.401	-0.107
Firmness by penetration of corn zein gum,MCG-9	1		1.088	-0.154
Firmness by penetration of cornzeingum,MCG-10	1		1.162	-0.081
Average:	1(F)		1.182	-0.113
S.D.	1(F)		0.470	0.031
Coef.of variation	1(F)	STDEV("BATCH")/AVERAGE ("BATCH")*100	39.723	-39.280

Table 5 :Firmness obtained by coating 3.

Test ID	Batch		Firmness in Kilograms Kg	Adhesiveness in Kilograms Kg
Start Batch 1	1			
Firmness by penetration of corn zein gum,MCG-1	1		1.737	-0.119
Firmness by penetration of corn zein gum,MCG-2	1		1.817	-0.091
Firmness by penetration of corn zein gum,MCG-3	1		1.288	-0.143
Firmness by penetration of corn zein gum,MCG-4	1		1.114	-0.134
Firmness by penetration of corn zein gum,MCG-5	1		1.209	-0.078
Firmness by penetration of corn zein gum,MCG-6	1		1.019	-0.124
Firmness by penetration of corn zein gu ,MCG-7	1		0.930	-0.160
Firmness by penetration of corn zein gum,MCG-8	1		1.354	-0.150
Firmness by penetration of corn zein gum,MCG-9	1		1.276	-0.149
Firmness by penetration of cornzeingum,MCG-10	1		1.294	-0.138
Average:	1(F)		1.304	-0.129
S.D.	1(F)		0.283	0.026
Coef.of variation	1(F)	STDEV("BATCH")/AVERAGE ("BATCH")*100	21.711	-20.540

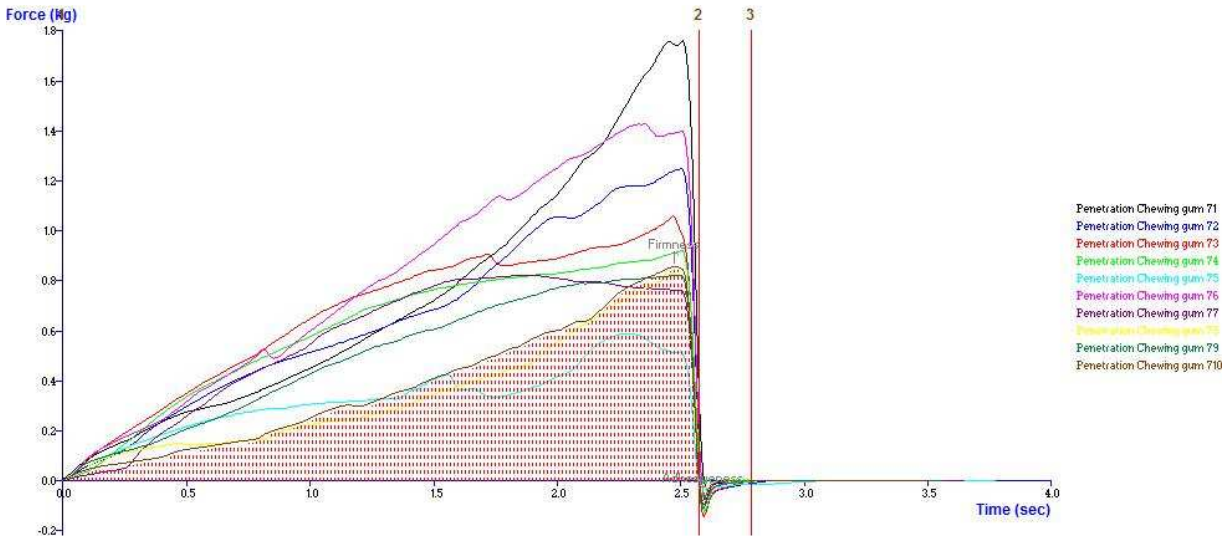

Fig 2: Overlap firmness curve obtained by coating 1.

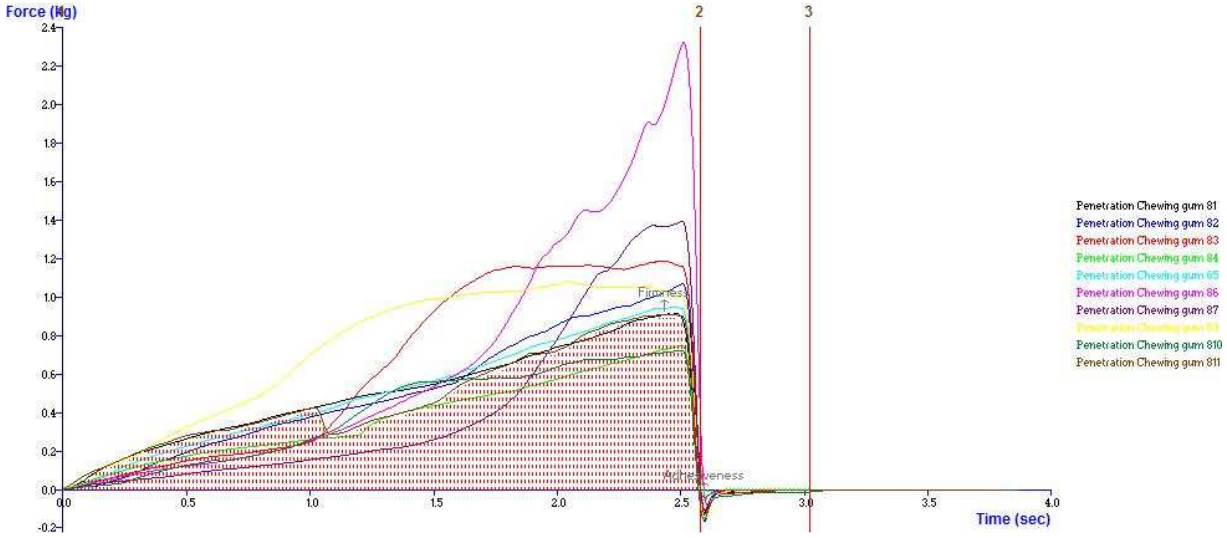

Fig 3:Overlap firmness curve obtained by coating 2.

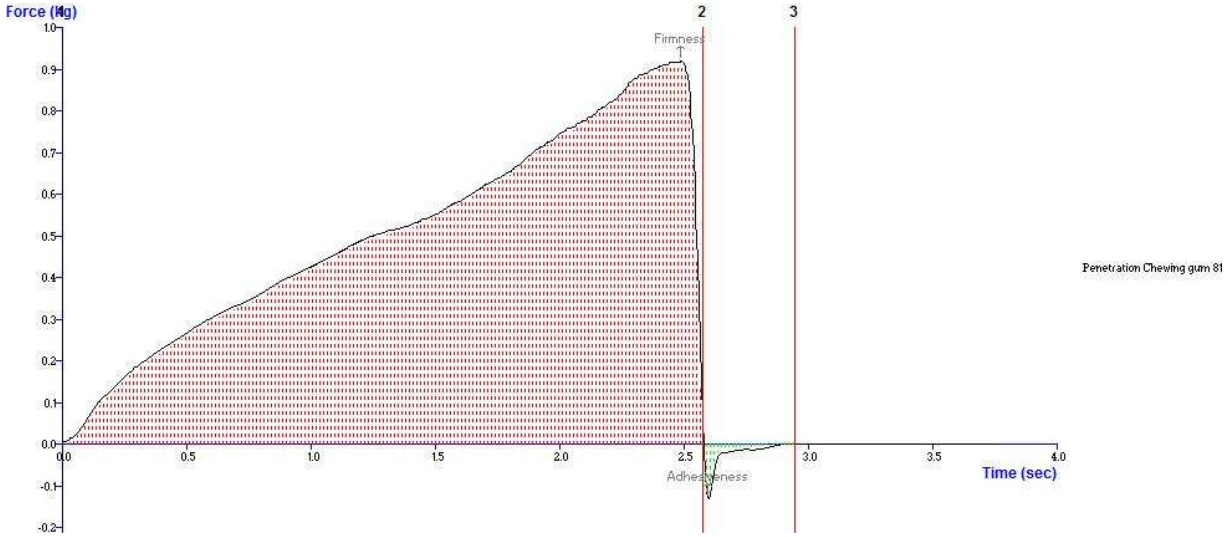

Fig 4: firmness curve obtained by coating 2 for MCG-1.

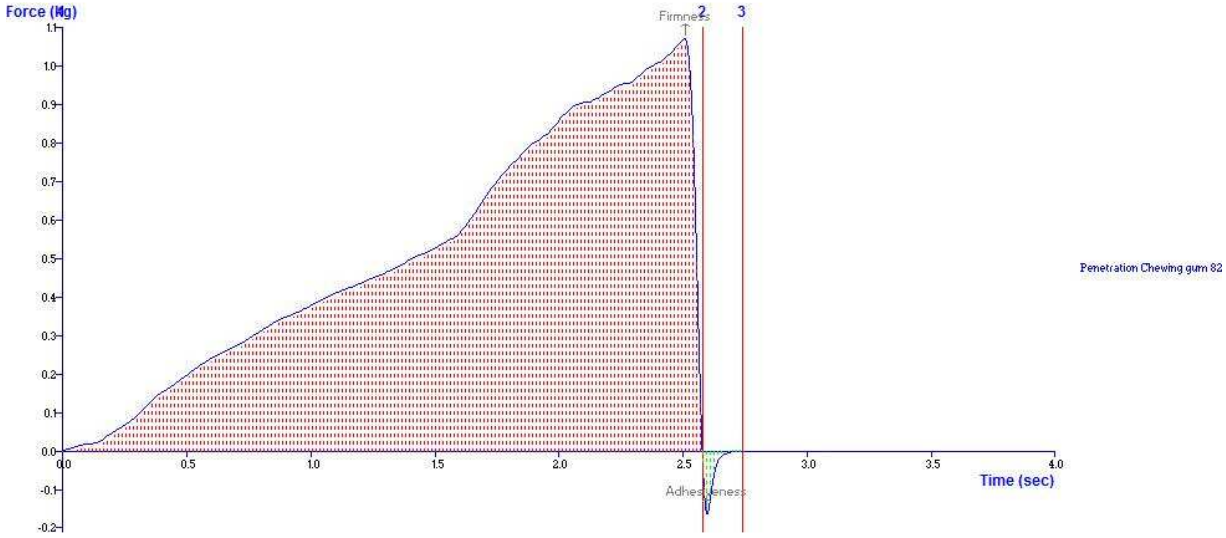

Fig 5: firmness curve obtained by coating 2 for MCG-2.

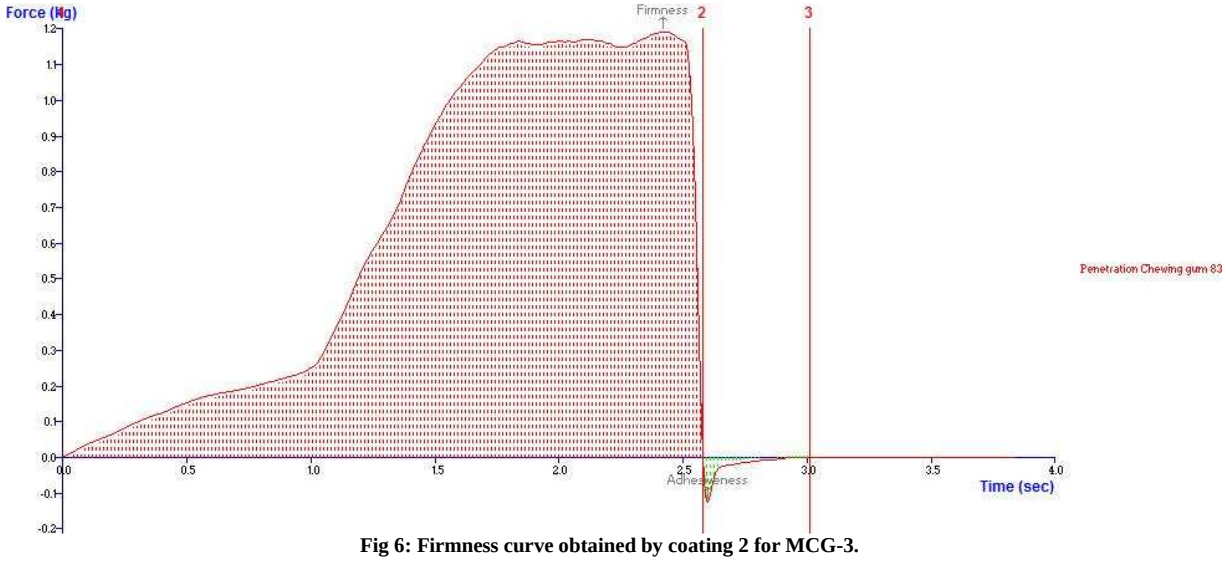

Fig 6: Firmness curve obtained by coating 2 for MCG-3.

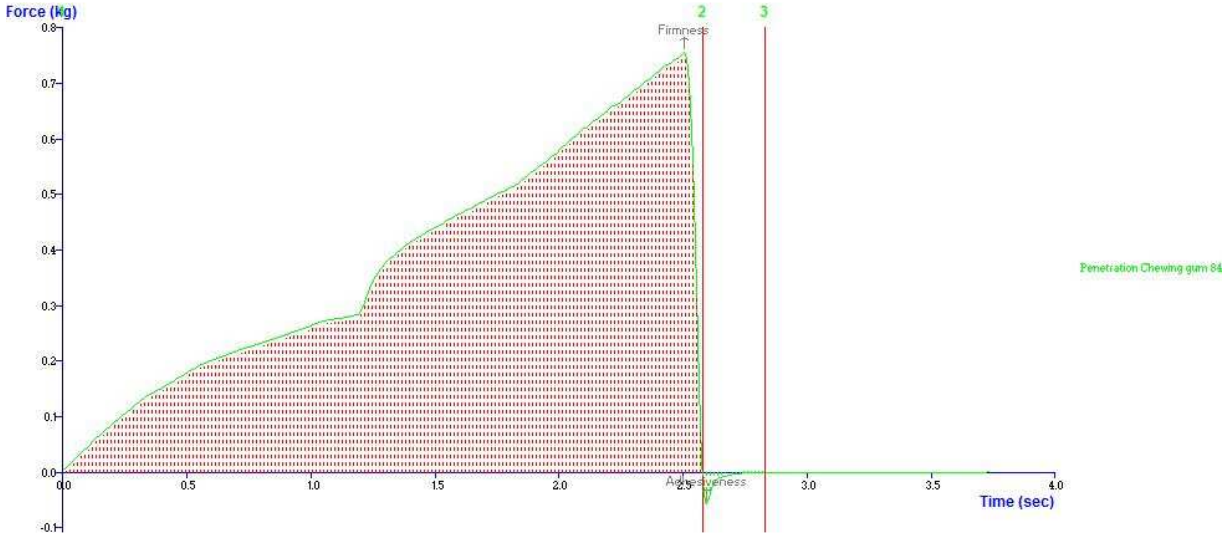

Fig 7: Firmness curve obtained by coating 2 for MCG-4.

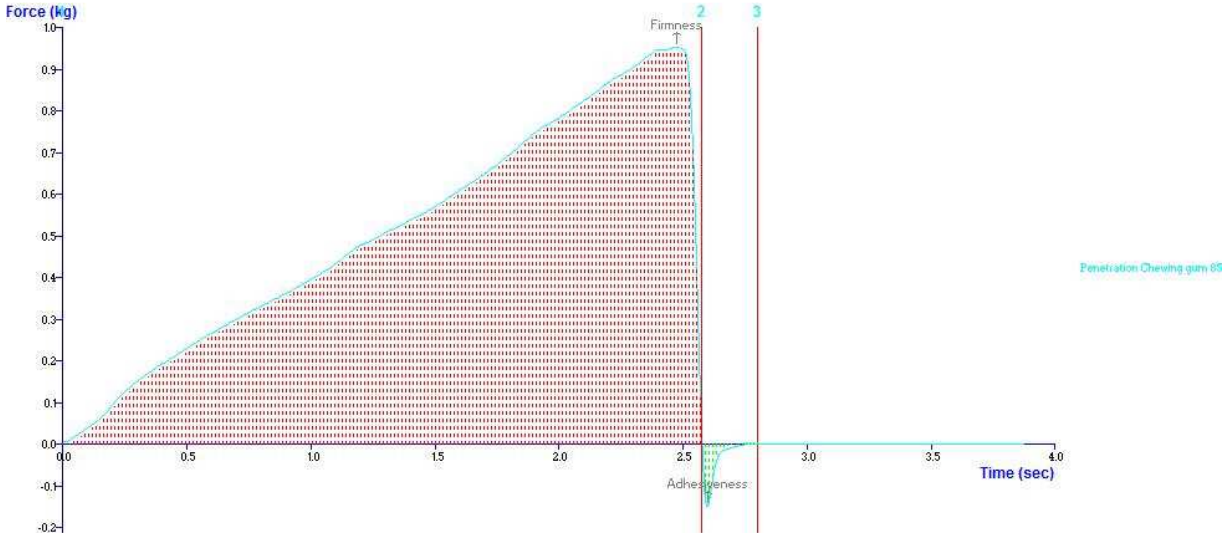

Fig 8: Firmness curve obtained by coating 2 for MCG-5.

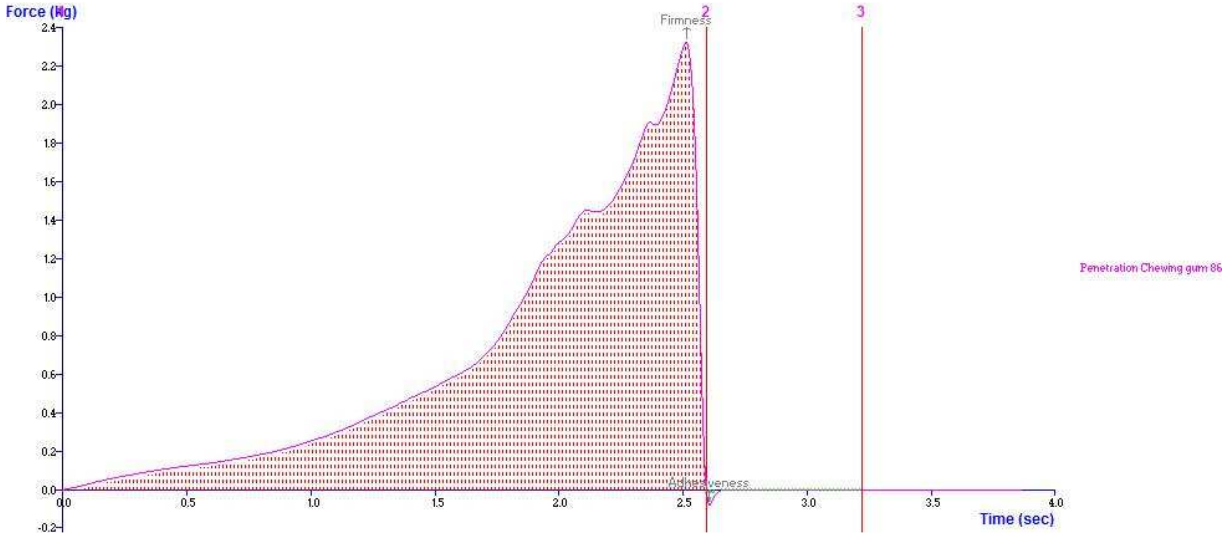

Fig 9: Firmness curve obtained by coating 2 for MCG-6.

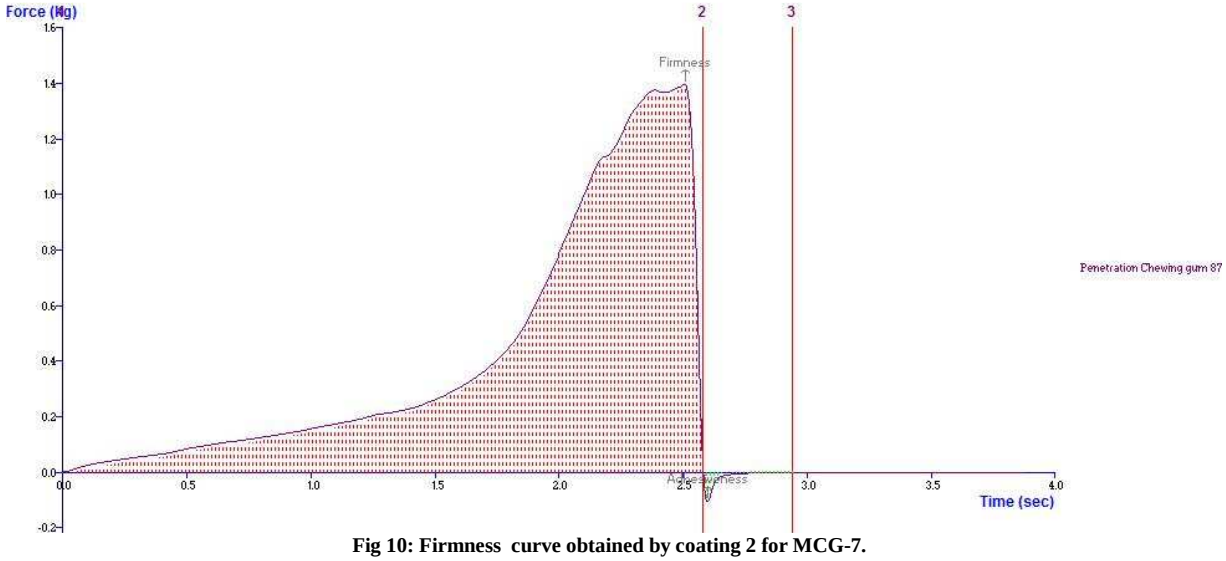

Fig 10: Firmness curve obtained by coating 2 for MCG-7.

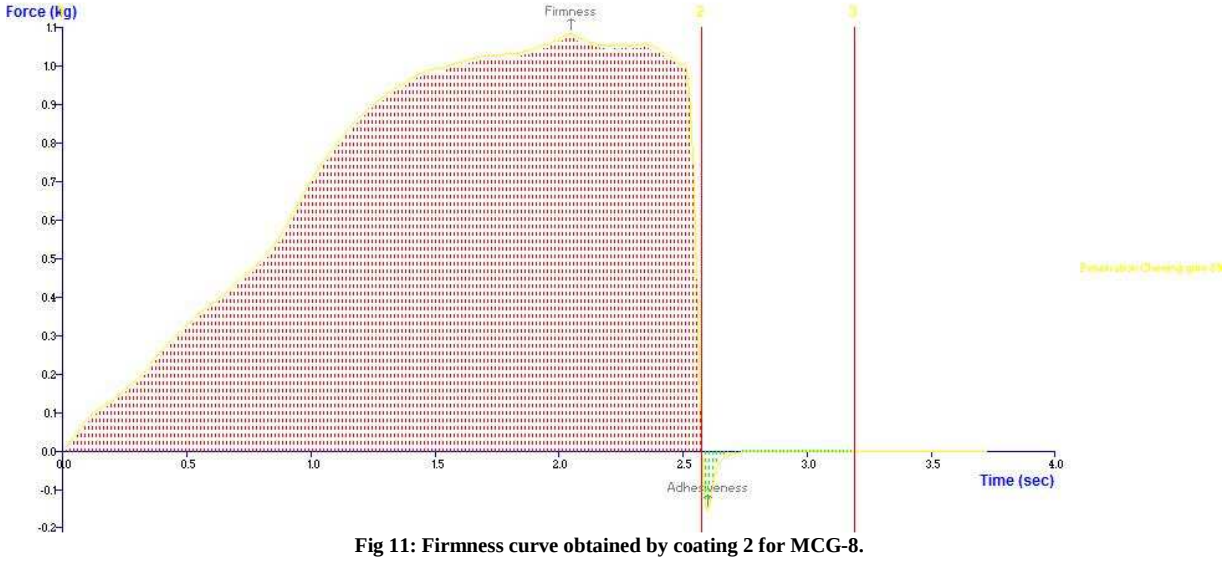

Fig 11: Firmness curve obtained by coating 2 for MCG-8.

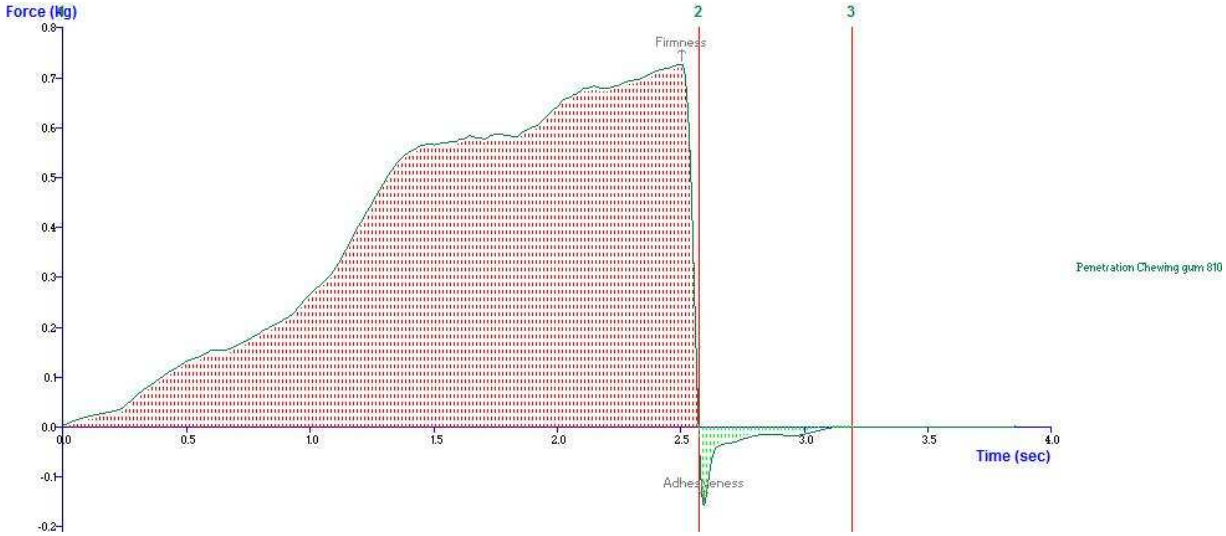

Fig 12: Firmness curve obtained by coating 2 for MCG-9.

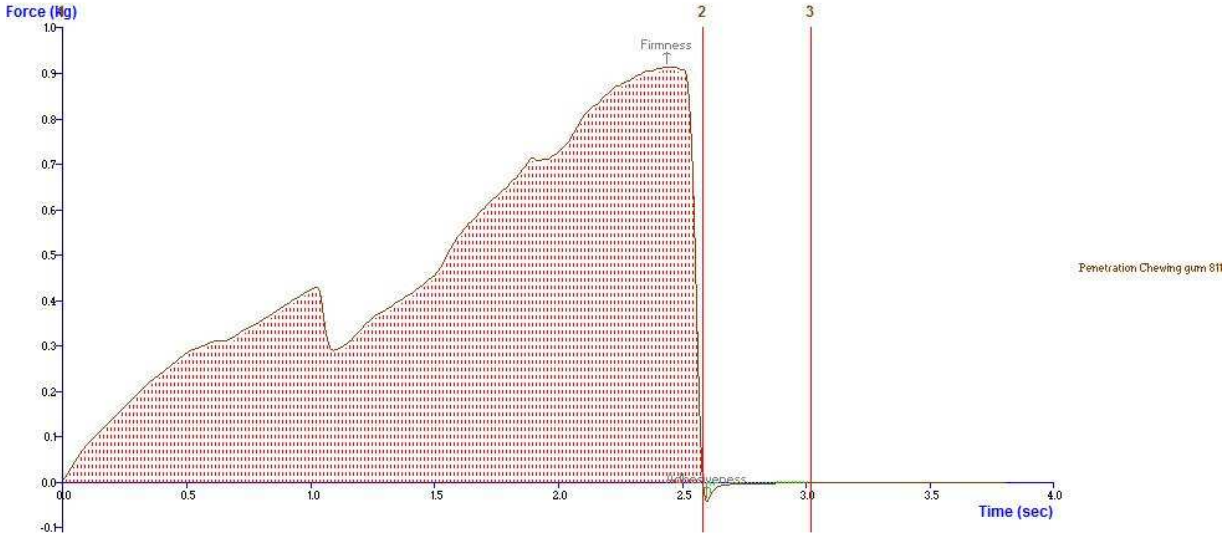

Fig 13: Firmness curve obtained by coating 2 for MCG-10.

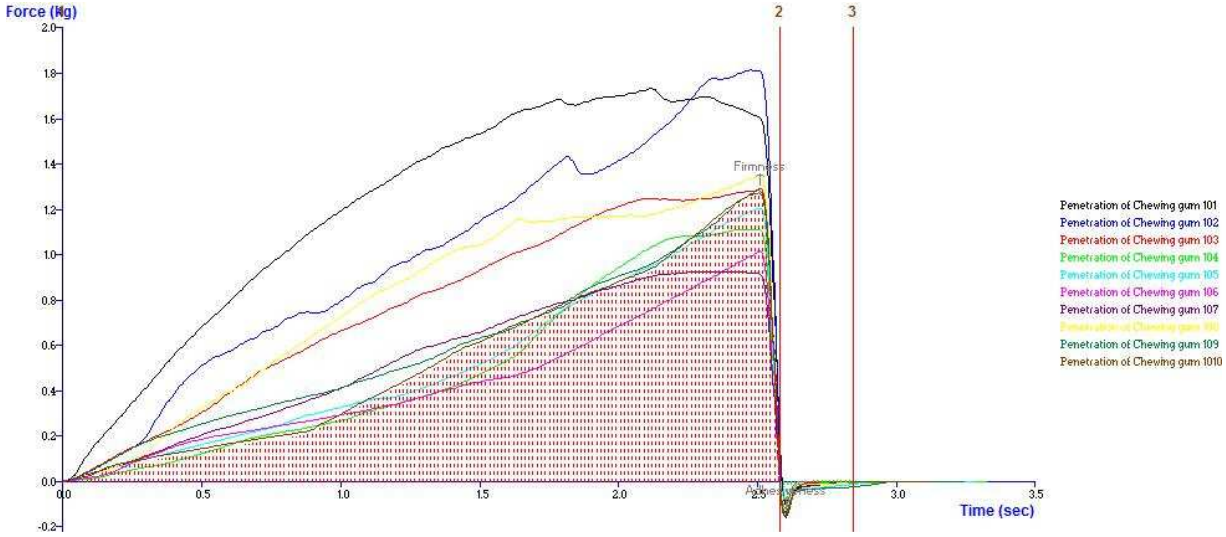

Fig 14: Overlap Firmness curve obtained by coating 3.

CONCLUSION

Effect of different formulations of chewing gum on final product's textural characteristics was successfully shown by Texture Analyser.

Corn-zein chewing gum samples were coated and these coatings are brittle in nature and thus shown as fracturability in the results obtained. Different values of fracturability (of coatings) are observed in the graphs.

Above studies show that all the parameters obtained by texture analysis by Texture Analyser from SMS, UK can be complemented by the sensory evaluation data. Coating 2 solutions which comprises of accasia 2%w/v,was reported with average coating firmness of 1.182kg and adhesiveness of (-0.113Kg), which is similar to values obtained with reference marketed preparations and considered best among other coating solutions.Maximum adhesiveness of (-0.043Kg) is shown by Palmitic acid which is used as plasticizer in MCG-1 formulation.

This study demonstrated the feasibility of using corn zein as a gum base and its potential for future optimization. Corn zein samples included in this study showed the potential for future optimization. The formulation containing triacetin demonstrating its desirable textural characteristics.

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