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# Formulation And Texture Characterization Of Environment Friendly Chewing Gum

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**Abstract:** Zein is a natural product, obtained from corn gluten. Rheological property of zein suggest its application as chewing gum base. Synthetic chewing gum base is very difficult to clean off surfaces because of its adhesive texture, and gum long lasting nature. Millions of dollars worldwide are spent for chewing gum waste disposal. Many researchers have investigated possibility of developing gum products that are biodegradable or less sticky in an attempt to remove these problems. In current study model corn zein chewing gum is developed and effect of formulation components on textural properties was investigated. Various plasticizers are used for formulation of corn zein chewing gum and Zein/N-oleoylsarcosine solution in various ratios was used as coating solution and effect of coating solution on textural properties was investigated.

Key words: Texture, corn zein, gumbase, chewing gum, N-oleoylsarcosine.

### **<u>1. Introduction:</u>**

#### Formulation of Corn Zein chewing gum

Zein is the water-insoluble prolamine from corn gluten, manufactured initially as a concentrated powder. It is unique in its ability to form odorless, tasteless, clear, hard and almost invisible edible films. Zein is one of the best understood plant proteins (1) and has a variety of industrial and food uses.(2-5) Zein is the water-insoluble prolamine from corn gluten. Zein has been used in the manufacture of a wide variety of commercial products, including coatings for paper cups, soda bottle cap linings, clothing fabric,textile(6-7),hair fixative(8),high potency sweetner (9) buttons, adhesives, coatings and binders.

The use of zein was in the textile fibers market where it was produced under the name "Vicara" .(10) With the development of synthetic alternatives, the use of zein in this market eventually disappeared. It is now used as a coating for candy, nuts, fruit, pills, and other encapsulated foods and drugs. In the United States, it may be labeled as "confectioner's glaze" and used as a coating on bakery products or as "vegetable protein." It is classified as Generally Recognized as Safe (GRAS) by the U.S. Food and Drug Administration.

Zein can be further processed into resins and other bioplastic polymers, which can be extruded or rolled into a variety of plastic products. With increasing environmental concerns about synthetic coatings and the current higher prices of hydrocarbon-based petrochemicals, there is increased focus on zein as a raw material for a variety of nontoxic and renewable polymer applications, particularly in the paper industry. Other reasons for a renewed interest in zein include concern about the landfill costs of plastics, and consumer interest in natural substances. There are also a number of potential new food industry applications. While there are numerous existing and potential uses for zein, the main barrier to greater commercial success has been its historic high cost until recently. Some believe the solution is to extract zein as a byproduct in the manufacturing process for ethanol or in new offshore manufacture.

#### **2. 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 laury sulphate (CDH New delhi), partially hydrogenated soya oil (Krishna Oil extraction limited, pachor, Rajgarh, M.P.), 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.

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.

# **2.2.** Method for making corn zein chewing gum samples (11)

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 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.(10) 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 .

S.N	Ingredient(%w/w)	MCG									
	-	1	2	3	4	5	6	7	8	9	10
1	Corn Zein(MMC)	25	25	25	25	25	25	25	25	25	25
2	Sodiumlauryl sulphat	2	2	2	2	2	2	2	2	2	2
3	Soya Oil	8	8	8	8	8	8	8	8	8	8
	Partially Hydrogenate										
4	Plasticizer	A 35	E 35	F 35	G 35	H 35	D 35	B 35	C 35	I 35	J 35
5	Mannitol	25	25	25	25	25	25	25	25	25	25
	Solution										
6	Filler Photoactive	5	5	5	5	5	5	5	5	5	5
	Titanium dioxide										

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

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S.No	Ingredient(%w/w)	Coating- 1	Coating- 2	Coating- 3	Coating- 4
1.	Gum base	25	25	25	25
2.	Zein/N-oleoylsarcosine	1:1	1:2	1:3	1:4

#### Table 2: Concentration of coating solutions

#### 2.3. Method for coating corn Zein formulations

Coating of MCG was done by liquid coating solution of zein and N octyl sarcosine (12).Zein was dissolved in 70 wt % isopropanol (30 % water) mixture to form a 10% solution. N octyl sarcosine was dissolved in the solution at a ratio of 1:10,1:20,1:30 and 1:40 by weight, a film was cast from 10 grams of the solution onto a flat bottom dish with a diameter of 60mm.It was allowed to dry for 48 hours followed by drying under vacuum(5mm of Hg) for 10 hrs. The film formed was clear, soft, suggesting good miscibility. This mixture was mixed in sigma blade laboratory mixture, the mixer was set at 50 degree Celsius and 32 rpm.The mixture was allowed to mix uniformly for 20 minutes. Gum pieces were dipped in the solution(ratio of 1:10,1:20,1:30 and 1:40 by weight) for coating and air dried. Table 2 shows concentration of four coating solutions.

#### 2.4 Characterization 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/firmness-Hardness is defined as the maximum peak force during the first compression cycle (first bite) and often been substituted by term firmness.
- 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 3-6) and (Figure 2-5).Coating 1 comprises solutions which of Zein/Noleoylsarcosine(1:1), was reported with average coating firmness of 1.049kg and adhesiveness of (-0.141Kg), coating solution 2 which comprises of Zein/N-oleoylsarcosine(1:2),was reported with average coating firmness of 1.191kg and adhesiveness of (-0.148Kg), and coating 3 solutions which comprises of Zein/N-oleoylsarcosine(1:3),was reported with average coating firmness of 1.200kg and adhesiveness of (-0.128Kg), 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).(13)

#### **Texture Analysis (TA) Settings (12)**

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



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

Cohesiveness= area 2/area 1Springiness= time2/time1Gumminess= hardness x cohesivenessChewiness= gumminess x springiness

# 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		0.467	-0.034
Firmness by penetration of corn zein gum,MCG-2	1		1.143	-0.200
Firmness by penetration of corn zein gum,MCG-3	1		0.925	-0.143
Firmness by penetration of corn zein gum,MCG-4	1		0.957	-0.196
Firmness by penetration of corn zein gum,MCG-5	1		1.566	-0.196
Firmness by penetration of corn zein gum,MCG-6	1		1.526	-0.104
Firmness by penetration of corn zein gu ,MCG-7	1		1.044	-0.139
Firmness by penetration of corn zein gum,MCG-8	1		0.948	-0.141
Firmness by penetration of corn zein gum,MCG-9	1		0.938	-0.127
Firmness by penetration of cornzeingum,MCG-10	1		0.971	-0.133
Average:	1(F)		1.049	-0.141
S.D.	1(F)		0.316	0.050
Coef.of variation	1(F)	STDEV("BATCH") /AVERAGE ("BATCH")*100	30.088	-35.440

# 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	1		1.441	-0.140
gum,MCG-1				
Firmness by penetration of corn zein	1		1.572	-0.115
gum,MCG-2				
Firmness by penetration of corn zein	1		1.098	-0.199
gum,MCG-3				
Firmness by penetration of corn zein	1		0.758	-0.127
gum,MCG-4				
Firmness by penetration of corn zein	1		1.353	-0.103
gum,MCG-5				
Firmness by penetration of corn zein	1		1.460	-0.175
gum,MCG-6				
Firmness by penetration of corn zein	1		1.050	-0.170
gu ,MCG-7				
Firmness by penetration of corn zein	1		0.695	-0.183
gum,MCG-8	1		0.070	0.120
Firmness by penetration of corn zein	1		0.869	-0.139
gum,MCG-9			1.618	0.100
Firmness by penetration of	1		1.617	-0.130
cornzeingum,MCG-10				
Average:	1(F)		1.191	-0.148
S.D.	1(F)		0.342	0.032
Coef.of variation	1(F)	STDEV("BATC H")/AVERAGE ("BATCH")*10	28.710	-21.387

# Table 5 :Firmness obtained by coating 3.

Test ID	Batch		Firmness in	Adhesiveness
			Kilograms Kg	in Kilograms Kg
Start Batch 1	1			
Firmness by penetration of corn zein	1		1.056	-0.167
gum,MCG-1				
Firmness by penetration of corn zein	1		2.094	-0.052
gum,MCG-2				
Firmness by penetration of corn zein	1		1.294	-0.175
gum,MCG-3				
Firmness by penetration of corn zein	1		1.006	-0.091
gum,MCG-4				
Firmness by penetration of corn zein	1		0.930	-0.133
gum,MCG-5				
Firmness by penetration of corn zein	1		1.042	-0.158
gum,MCG-6				
Firmness by penetration of corn zein	1		1.267	-0.120
gu ,MCG-7				
Firmness by penetration of corn zein	1		1.303	-0.116
gum,MCG-8				
Firmness by penetration of corn zein	1		0.912	-0.106
gum,MCG-9				
Firmness by penetration of	1		1.096	-0.163
cornzeingum,MCG-10				
Average:	1(F)		1.200	-0.128
S.D.	1(F)		0.345	0.039
Coef.of variation	1(F)	STDEV("BAT	28.771	-30.605
		CH")/		
		AVERAGE		
		100		
		100		

## Table 6 :Firmness obtained by coating 4.

Test ID	Batch		Firmness in Kilograms Kg	Adhesiveness in Kilograms Kg
Start Batch 1	1			
Firmness by penetration of	1		0.765	-0.048
Firmness by penetration of corn zein gum,MCG-2	1		1.797	-0.110
Firmness by penetration of corn zein gum,MCG-3	1		1.684	-0.084
Firmness by penetration of	1		1.462	-0.141
Firmness by penetration of corn zein gum,MCG-5	1		0.768	-0.104
Firmness by penetration of corn zein gum,MCG-6	1		1.399	-0.091
Firmness by penetration of corn zein gu ,MCG-7	1		0.946	-0.062
Firmness by penetration of corn zein gum,MCG-8	1		1.235	-0.144
Firmness by penetration of corn zein gum,MCG-9	1		1.179	-0.133
Firmness by penetration of cornzeingum,MCG-10	1		1.561	-0.073
Average:	1(F)		1.280	-0.099
S.D.	1(F)		0.366	0.033
Coef.of variation	1(F)	STDEV("BA TCH")/AVE RAGE ("BATCH")* 100	28.640	-33.663



Fig 2: Overlap firmness curve obtained by coating 1.



Fig 3:Overlap firmness curve obtained by coating 2.



Fig 4: Overlap Firmness curve obtained by coating 3.



Fig 5:Overlap firmness curve obtained by coating 4.

#### 3. Summary and 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 and firmness 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-3 solution which comprises of Zein/Noleoylsarcosine (1:3),was reported with average coating firmness of 1.200kg and adhesiveness of (-0.128Kg), which is similar to values obtained with reference marketed preparations and considered best among other coating solutions.Maximum adhesiveness of (-0.175Kg,by coating 3) is shown by urea which is used as plasticizer in MCG-3 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 coated with coating-3 solution which comprises of Zein/N-oleoylsarcosine(1:3) demonstrated desirable textural characteristics.

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