

Quality Improvements in Chewing Gums using Lecithins (Flexibility, Hardness & Taste)

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Summary

The screening of a range of lecithin types demonstrates that the bland tasting Deoiled and Hydrolyzed Lecithins perform even better than standard fluid Lecithin in low and medium liquid phase gums. Flexibility and Hardness are measured on an Instron-Dynamometer representing the quality of the gum during chewing, and these quality parameters are both improved. The role of the vegetable oil in native Lecithin and the possibility of incorporating various amounts of oils- and fats were also investigated as softening agents. The regulatory environment is changing in terms of GMO technology and new alternative types of Lecithins are suggested.

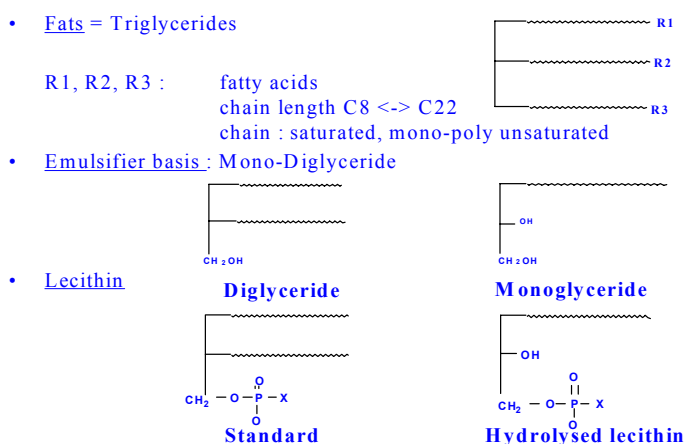
Introduction

The significance of using Lecithin in chewing gum is perhaps best illustrated by the following quick search in the Mintel New-Product-Development database, Table 1. This Internet tool is available to subscribers and the information is based on local shoppers who continuously shop for any new products ever since 1997 (the other confectionery registration categories are: “Chocolates”, “Sugar” and “Other”). In many cases Lecithin or Emulsifiers are probably used in the gum base, but simply not declared on the retail product level. In some cases the novel product may not be a classical gum formulation using any of the expected emulsifiers. Lecithins will continue to be a useful ingredient in gums in light of the market trends for fortified-, organic- and natural products.

Gum Confectionery New formulations, products, variety and range extensions	New Launches since '97 Europe, Middle-East, Africa	New Launches since '97 America's, Asia Pacific
Labelling Lecithin or E 322	85	77
Labelling Emulsifiers	84	28
Labelling Monoglyceride or E 471	4	1
All New Gum Product Launches	537	592

Table 1: Gum Confectionery Launches by Mintel International www.gnpd.com, January 28, 2003.

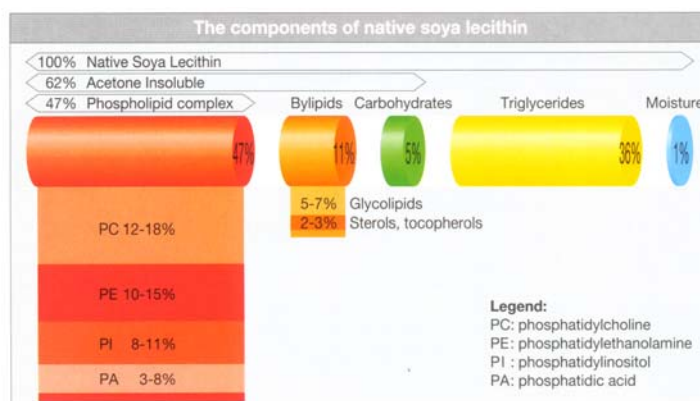
The key to the functionality of Lecithins is found in its molecular structure. Based on this, one can logically expect a great analogy between the functionality of Man-made diglyceride based emulsifier types and then the natural based Lecithin “extracts”. The special feature for the Lecithins is the unique phosphorylated group in the 3-position.



GL4 - E - 1

Figure 1: Relative Molecular Structures of Diglyceride Origin

Figure 2 illustrate the mix of components in Lecithin and as seen later a number of functionally different Lecithins exist within the E-number 322. The following experiments show that in practical chewing gum work, one should differentiate between “standard” lecithin and “deoiled” or dry lecithins.



GL5 - E - 1

Figure 2: Natural Components Mixture of Lecithins

Case Example of Improving Chewing Gum Qualities

Table 2 gives an overview of the benefit portfolio from Lecithins based on practical experiences and patent reviews. This presentation monitors the common denominators Hardness, Flexibility and Flavor as these represents the quality of the gum during chewing.

Benefits of Using Lecithins
Softens Gum Base and Chew
Regulates Adhesive Properties
Reduces Tackiness/Stickiness
Improves Flavor Perception and Longevity
Enhances Resiliency and Stretch
Improves Shelf Life – Flexibility and Moistness
Reduces Toughness and Elasticity
Improves Bubble Formation

Table 2: Overview of Benefits from Lecithins

Table 3 illustrates the 2 formulations used for the comparison of Lecithin properties. All information on the gum preparation method and analytical procedures are listed in the Appendix. The results reported in this paper focus the low liquid phase model because this type of chewing gum remains softer and easier to measure during storage – and because they become more popular in the industry. The brittleness of the medium liquid phase gum is a result of crystallization of the Sorbitol syrup (with 30 % moisture).

Ingredient	Low Liquid Phase Gum %	Medium Liquid Phase Gum %
Gum Base, Eurobase, Belgium	35	30
Sorbitol Cerestar, powder	45,5-45,3	47,5-47,3
Mannitol Cerestar, powder	15	-
Sorbitol Cerestar, syrup	-	20
Glycerol	2	0,5
Lecithin	0,5-0,7	0,5-0,7
Mint Flavor	2	2

Table 3: Sugar free Chewing Gum Model System

In most of the significant food application situations the key component for the functionality of lecithin is Phosphatidylcholine (the X-group in Figure 1 is Choline, recently nominated as an essential nutrient). The content of Phosphatidylcholine or PC can be enhanced dramatically through the pathway of ethanol fractionation. However, the *first pre-trials* in above low liquid phase gum and in Lecithin dosages of 0,3 %, showed a clear positive effect of standard fluid lecithin as opposed to any of the fractionated lecithins.

This turns the focus towards other “processed” and “deoiled” Lecithins. Table 4 lists some additional types of Lecithins that will prove very valuable. The standard fluid Lecithin is the reference. The hydrophilicity of Lecithins can be shifted through enzymatic hydrolysis of one of the 2 fatty acids (see Figure 1) and even more by acetylating (of amino groups) and by hydroxylation (of unsaturated fatty acids). Please note, that the last 2 types of Lecithins have no E-number for European food usage. Deoiled Lecithins are available offering the deoiled CENTROLEX F and the deoiled-and-hydrolyzed PRECEPT 8160. The process of deoiling Lecithins leads to remarkable functionality and product characteristics (see simple illustration in Figure 3).

Lecithin Type	Trade Name	Legal Status
Standard fluid Lecithin	STERNCITHIN F-10	E 322
Deoiled Lecithin	CENTROLEX F	E 322
Hydrolyzed fluid Lecithin	STERNPHIL E 60	E 322
Hydrolyzed deoiled Lecithin	PRECEPT 8160	E 322
Hydroxylated fluid Lecithin	CENTROLENE A	21 CFR 172.814

Table 4: Investigated Types of Lecithins



Figure 3: Characteristics of Deoiled dry Lecithins

The *second pre-trials* used 0,5 % (weight) Lecithin dosages, regardless of content of phospholipids, measured as Acetone Insoluble (the AI for standard- and deoiled lecithin is respectively 60 and 95 %). Since the second pre-trials were the last ones to include standard Lecithin as a reference, Table 5 plots some of the most illustrative results. The controls were made at the beginning and at the end of the series and monitors the base-levels and not the least the experimental variability. Once again there was a noticeable performance change of the Lecithins over storage time in terms of Flexibility and Hardness. It deserves mentioning that one can see change of Hardness levels between different test series, if one change batches of gum base or just the flavor dosages.

Lecithin	Flexibility Number of Cycles at Breaking			Flexibility Force at Breaking (g)			Hardness (g) 45 °C
	fresh	2 months	3 months	fresh	2 months	3 months	
Control 1	13	4	3	2200	700	550	6900
Control 2	10	3	3	2450	700	700	9400
STERNCITHIN F-10	16	13	13	2500	2300	2000	9000
CENTROLEX F	22	8	3	2250	1500	600	8000

Table 5: Main Results of Pre-trials

Correlation Factors were calculated at a fixed Cycle level for Flexibility and Hardness Values and showed wide scattering from 0,4 to 0,97. This analysis led to the consideration in how far the adhering native soya oil in some of the Lecithins might have a softening effect as well? If not, the deoiled Lecithins would have more functional value and offer an additional better flavor profile. The final test design appears from Table 5. In this case Lecithin dosages were “adjusted” for Acetone Insoluble in order to achieve a fair Phospholipid comparison.

Lecithin Ingredient	Lecithin Dosage %	Adjusted Acetone Insoluble %
Soya oil	0,5	0
CENTROLEX F	0,5	0,5
CENTROLEX F + 0,1 % soya oil	0,5	0,5
CENTROLEX F + 0,2 % soya oil	0,5	0,5
CENTROLEX F + 0,2 % cocoa butter	0,5	0,5
STERNPHIL E 60	0,7	0,5
PRECEPT 8160	0,5	0,5

Table 5: Final Test Design in Low Liquid Phase Model system

Lecithin	Flexibility Number of Cycles at Breaking			Flexibility Force at Breaking (g)			Hardness (g) 45 °C
	fresh	2 months	3 months	fresh	2 months	3 months	
Soya oil	7	2	7	1100	650	2000	4400
CENTROLEX F	19	7	6	3800	2100	1500	4200
CENTROLEX F + 0,1	19	8	6	3700	2200	1700	4200
CENTROLEX F + 0,2	14	3	4	3375	800	1200	4400
CENTROLEX F + 0,2 Cocoa butter	17	10	8	3800	2350	1800	4100
STERNPHIL E 60	19	2	3	2450	400	600	4250
PRECEPT 8160	14	6	6	4750	1850	1800	4600

Table 6: Main Results in Final Test of Low Liquid Phase Model system

The results of the final experiments appear from Table 6. The Flexibility measurements were based on 0-3 month's storage at 37 °C. As explained in Appendix, the repeatability of Cycles before Breakage is 2-3 Cycles. Since the cycling chamber is maintained at a temperature of 12 °C, the Force at the Breakage point is inevitably larger for any sample that survives more cycling. Consequently it is better to rely on Number of Cycles and Hardness when comparing the performance of samples. Hardness was actually measured at 45 °C, 50 °C and 55 °C. The listed Hardness data are for a temperature of 45 °C since this generally showed most differentiation.

Generally the Lecithins perform well compared to the soya oil control. The deoiled CENTROLEX F does very well and the addition of 0,2 % cocoa butter appears to improve Cycles and Hardness whereas addition of 0,2 % soya oil has a negative impact. Literature also indicates that oils have different effects in different gums and the observations can only be valid for the present model system.

The fluid hydrolyzed STERNPHIL E 60 show promise, although it has low cycles after 3 months. Again the deoiling in the PRECEPT 8160 is an advantage - and one concludes that the deoiled Lecithins CENTROLEX F and its "sister" PRECEPT 8160 have the best overall performance. The deoiled CENTROLEX F gives the softest gum under the present circumstances. One can clearly rate Lecithin types per their Hydrophilic properties, or HLB values, as follows: deoiled hydrolyzed Lecithin > deoiled Lecithin >> standard Lecithin. Since gum bases are generally water insoluble it is possible that deoiled Lecithins are more suitable. Likewise, the choice of Lecithin type may influence flavor perception of water soluble components as indicated in the patent literature.

During the entire work no off tastes were noticed. In case specific applications are sensitive to off flavors from Lecithins then deoiled Lecithins would have additional value since the oxidation sensitive native oils have been removed.

As always when working with Lecithins, the exact performance is very dependent on a particular formulation and the purpose of this model experiment is to encourage formulators to screen for the optimal lecithin type.

Future Lecithins

The use of Lecithin is very popular and it is a significant challenge for the food industry that there will be less and less Lecithin available from non genetically modified soya beans – simply because the farmers in North and South America as well as in Europe have bigger economic incentive to grow GMO beans. The price premium of non GMO Lecithin does not justify the growing and crushing of non GMO beans since the content of Lecithin in the soya beans is only 0,5 %. It is also a challenge for the food industry that the European Commission is developing legislation which will make labelling of products made from genetically modified raw materials compulsory. This scenario describes a critical situation for the many Lecithin users throughout the food industry. It will make it even more important to know where the raw material for your Lecithin comes from!



Now there are new non GMO Lecithin's under E 322. For the first time Cereol-Central Soya has developed 2 new sources of vegetable Lecithin's in very large scale and in dependable quality. Cereol-Bunge is the largest crusher of European grown rape seeds and sunflower seed kernels - in the crushing industry referred to a "Soft Seeds" as opposed to soya bean, which is a harder seed. When carefully refined the soft seeds offer similar Lecithin yield as soya beans, astonishing quality and functionalities at least as good as soya bean Lecithin. Since the use of genetically modified organisms will only expand in the future Central Soya is backing up our new rape- and sunflower seed Lecithin's with "Identity Preservation Programmes" in order to ensure that the new Lecithin's remain of non GMO origin.

Table 7 demonstrates the variability of the main phospholipids in different vegetable Lecithins. The new rape seed and sunflower seed Lecithins will function completely equivalently to soya Lecithins since experiments in this model system indicate that the content of Phosphatidylcholine is not critical to the performance in chewing gum. The new vegetable Lecithins are from different plant species; they do have different flavor profile and it is recommended to verify the flavor compatibility in the existing gum systems.

Selected Phospholipid Isomers	European Soya Bean Lecithin	Brazilian Soya Bean Lecithin	European Rape Seed Lecithin	European Sunflower Seed Lecithin
	STERNICITHIN F-10	STERNICITHIN B-10	CENTROSOFT RF-10	CENTROSOFT SF-10
	Typical %	Typical %	Typical %	Typical %
Phosphatidylcholine PC	14	15	17	17
Lyso-Phosphatidylcholine	1,3	0,7	1,2	1,0
Phosphatidylethanolamine PE	10,3	11,2	8,0	7,9
Lyso Phosphatidylethanolamine	0,4	0,3	0,4	0,3
Phosphatidylinositol	9,8	10,4	11,4	14,5

Table 7: Comparison of Key Components in Vegetable Lecithin's per Origin and Plant Species

Appendix

Preparation Method for the Gums

Mix desired gum base at 55 °C in a Z-blade Winkelworth kneader with Mannitol and 65 % of the Sorbitol for 5 minutes.

Knead-in the desired Lecithin for 2 minutes, followed by glycerin for 2 minutes.

Mix in the remaining Sorbitol for 5 minutes, add desired flavor and knead for the last 4 minutes.

Total mixing time is 18 minutes.

Cool the gum for 10 minutes to 60 °C before extruding the ropes in the Togum rope processor (1'st zone 40 °C, 2'nd zone 45 °C).

Specific Ingredients used in the Gums

Sorbitol Cerestar Powder:	Cerestar Sorbidex P16616
Sorbitol Cerestar Syrup:	Cerestar Sorbidex NC 16205
Mannitol Cerestar Powder:	Cerestar Mannidex 16700

Flexibility Test

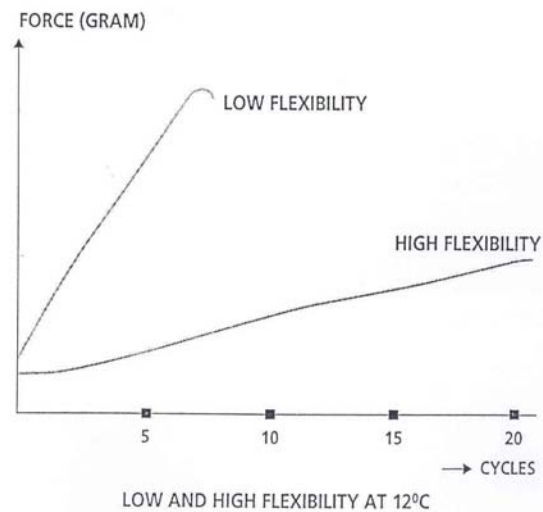
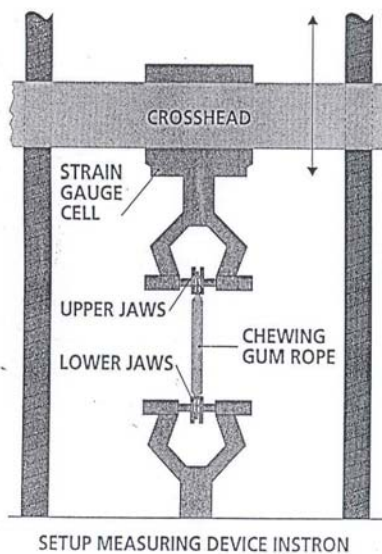
Insert the extruded rope between the 2 jaws of the Instron-Dynamometer at 44 °C and with a cross section of 1 square cm. Move the cross head down by 9 % in order to obtain a bended rope. Set the mode switch on Cycling. The cooling temperature in the chamber is 12 °C. Record the number of cycles before breakage of the rope and the increasing forces until breakage (Flexibility). The earlier experience in working with the instrument is a repeatability of 2-3 Cycles before sample breakage.

No records were made for the sample temperature during the cooling. The better the Flexibility (higher number of cycles) the colder the sample becomes until 12 °C is reached.

Flexible gum samples will register higher breaking forces primarily due to the temperature-texture effect.

▼ Flexibility Measurement Chewing Gum

- ▼ Evaluation of chewing gum rope flexibility at a certain temperature
- ▼ profile (check for processability and texture)



Hardness Test

Fill plastic cups with extruded chewing gum mass and cool from 55 °C to 45 °C. Penetrate an Instron cylindrical plunger with a cross section of 1 cm and for 10 mm into the gum.

Sensorial Evaluation

Selected samples have been tasted after 3 months storage by a trained taste panel.