The Study of Possibility to Enhance Beer Foam Stability by Adding Gum Arabic

Mr. Chuchart Seinglewlue

A special problem submitted to the Faculty of Biotechnology, Assumption University, in part fulfillment of the requirements for the degree of Bachelor of Science in Biotechnology

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Senior Project

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By

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1999

Title	: The Study of Possibility to Enhance Beer Foam Stability by Adding Gum Arabic
By	: Mr. Chuchart Seinglewlue
Advisor	: Dr. Churdchai Cheawtirakul
Level of Study	: Bachelor of Science
Department	: Food Technology
Faculty	: Biotechnology
Academic Year	: 1999

c. cheawtirakul
_____ Advisor
(Dr. Churdchai Cheawtirakul)

Abstract

This project is intended to study the enhancing of foam stability in beer brewing, by adding gum arabic. 0-3% of gum arabic is added to the normal procedures of beer making. The results shown that, 5.02,6.94,8.04 and 9.02 minutes of foam dropping were obtained from the adding of 0%, 1%, 2% and 3% of gum arabic respectively. From the result of this study we can conclude that the adding of gum arabic is indeed increasing the foam stability of beer. But adding of gum arabic also trickle another problem. That is the increase of turbidity in beer, which is yet remained for another study.

Acknowledgements

May I dedicate this work to my advisor, other teachers, and all dear friends. Without these people, this work will never been done. Through out this project, I had encountered many problems, but they were so little, comparing to all the support that those people had given to me. The encouragement from them is so great, and I really appreciate for their help. I am impressed and will keep it in my memory forever.

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Introduction

Beer is a carbonated alcoholic beverage, which is very popular in Thailand. Most the Thai like to drink high quality beer. In term of quality, good beer need good color, taste, aroma and foam stability. For all the beers produced in Thailand in the past, there was always some problem with foam stability when compared to the foreign beer.

Beer foam is formed when carbon dioxide (from carbonation) reacts with proteins (from malt) in the beer when it is opened or poured. Foam stability could be enhanced, by increasing the protein to carbon dioxide ratio. Gum arabic is glycoprotein, which can form hydrophobic polypeptide and help the stability of foaming.

This research was aimed to study the possibility to enhance beer foam stability by adding gum arabic.

Objective

This project is intended to study the possibility to enhance beer foam stability by adding gum arabic.

Literature Review

Brewers have been developing the quality of beer by conducting many researches on the brewing process. The specializations cover issues of real pertinence to maltsters and brewers have primarily focus on quality of products from both industries.

Amongst the key research themes are the following:

1.Flavor stability

Achieving good flavor life in beer is the principal technical challenge faced by the brewing industry (Bamforth, 1998).

2. Relating beer analysis to perception

There are simple correlations between the composition of beer and its perceived quality. It is a problem when trying to establish a link between measured volatile components in a beer and its perceived flavor (Hegarty, Parsons, Bamforth & Molzahn, 1995).

3. The composition and breakdown of cell wall in barley

The walls surrounding the cells in the food reserve of barley comprise four main components: b-glucan, pentosan, protein, and phenolic acid. Efficient breakdown of these walls is needed during germination phase of malting if the viscous polymers, especially glucan are not going to present a problem to a brewer. Although the gross composition of the walls is known, there is very little understanding of how the various components interface in the wall (Moore, Bamforth, Kroon, Bartolome & Williamson, 1996).

4. Foam stability

Although the demand for a stable foam on a beer is different globally, need which brewers have to deliver a beer with a stable head in those markets where it is necessary is manifest. Bamforth's work has already demonstrated that hydrophobic polypeptides form the basis of stable foams (Bamforth, 1999).

Brewer still need research to be conducted for enhancing beer foam stability. To do research, the basics of foam have to be known.

Foam Forming

There are hydrophilic and hydrophobic compounds in beer. Beer also has compounds called glycoproteins that are part hydrophilic and part hydrophobic. The head of molecule hates water, but the tale likes it. When many of these compounds gather together on the top of beer, the heads group together in a circle creating a pocket of CO_2 and foam occur (Alex Fodor, 1998).

Foam Collapse

At any temperature, the gas pressure in the headspace and the amount of gas dissolved in the beer are constant. When the bottle of beer is opened, there is imbalance between the amount of CO_2 in the beer and the amount of CO_2 in the atmosphere above the beer. The amount of CO_2 in the air is only 0.2 percent of the total atmosphere, compared with 98 percent in a beer headspace. To restore equilibrium, the CO_2 bubble will leave the beer until balance is restored. That is why an open beer will always go flat over time (Alex Fodor, 1998).

Points considered to have good foam

- Bittering hops are head builders.
- Properly carbonate.
- Avoid diluting protein with low protein adjucts(corn, rice, sugar).
- Fat and detergents tend to destabilize the bubbles and make foam collapse.
- High viscosity beer has more foam stability.

- Dirty glass or soap residue will collapse foam.
- Use nitrogen and carbon dioxide mixture for carbonation can help foam collapse slowly.
- Malt extracts may lose foam positive characteristics during processing.
- Heading compound can increase beer foam.
- The foaming compounds do not form foam a second time.

The research for enhancing beer foam stability can be created when consider above information (Alex Fodor, 1998).

The researches involved foam are following:

1. Collaborative determination of beer foam stability by Rudin and Nibem(Sharpe, F. R., 1998).
2. Development of monoclonal antibody sanwich-ELISA for determination of beer foam-active proteins (Kakui, T., et al., 1998).
3. Natural foam stabilizing and bittering compounds derived from hops (Smith, R.J., Davidson, D., Wilson, R.J.H., 1998).
4. Mathematical modeling of beer foam (Gerry Melm, Paulina Tung, and Alistair Pringle, 1995).

One of the possibilty of enhencing the foam stability of beer is by adding gum arabic. Gum arabic is natural product of the *Acacia Senegal* tree, occurring as an exudate from the trunks and branches. It is normally collected by hand when dried, when it resembles a hard, amber-like rasin. Gum arabic is grounded to the fine powder before used. It consists of 2% protein, rich in hydroxyproline, serine, and proline, though to form a central core of the molecule, and a complex carbohydrate coat based upon b-1,3-linked galactose units. Properties of gum arabic can be seen in *table 1.* Application of gum arabic can be seen in *table 2.*

Supporting reasons to use gum arabic to enhance foam stability:

1. Foam forming compound in beer is glycoprotein(Alex Fodor,1998) and gum arabic is glycoprotein(Qi, W., Fong, C. & Lamport, D.T.A.,1991).
2. Gum arabic is insoluble in alcohol, therefore the adding of gum arabic in wort will not interfere with alcohol content in beer.
3. Gum arabic is flavor encapsulator, product made with gum arabic will have a much quicker and sharper flavor release profile, and may also enable a reduction in the amount of flavor using thereby effecting further cost efficiencies.
4. Gum arabic is safe to the consumer.
5. Beer foam-active proteins can be determined by using monoclonal antibody use in ELISA (Kakui, T., et al., 1998) and gum arabic can be detected by using the same method(Deway, Thurston & Cronk, 1997). It means gum arabic may consisted of foam-active protein.

All the researches cited above did not mention directly the method of enhancing foam stability in brewing industry. In order for a research of our interested to be useful, the method should be able to implement directly to the industry, safe and not cost expensive. We expect that this project, the study of the possibility to enhance beer foam stability by adding gum arabic will meet these requirements.

Materials and Methods

Part1. Brewing beer

Raw materials : 1. Water
2. Malt extract from FIS
3. Hop
4. Dry yeast
5. Gum arabic
6. KMS

Procedure

Water 5 L.
↓
Add malt extract until 12 Bx
↓
Heat to 80-90 C and keep temp.
↓
Add hop 15 g. and Stir for 1 hr.
↓
Add gum arabic(0-3%)
↓
Add hop 15 g. andStir for 5 min.
↓
Heat until boil
↓
Turn off fire
↓
Whirlpool and Cool down
↓
Rack and add KMS
↓
Close lid and shake
↓
Add yeast and shake
↓
Leave at RT until gain 6% alcohol
↓

Filter

↓

Carbonation

↓

Storage

During fermentation, the following parameters were measured

1. Total Soluble Solid(TSS)
2. pH
3. Percentage of alcohol
4. Total acid(TA)

After fermentation completed, Optical Density(OD) value was measured by using spectrophotometer.

Part2. Measuring Foam Stability

After finishing part 1, each product was poured into the glass (60 mm. Diameter) and left foam fall for 35mm. And record the time taken.

Results

Part 1. Brewing beer

Figure 1. Changes in TSS during fermentation

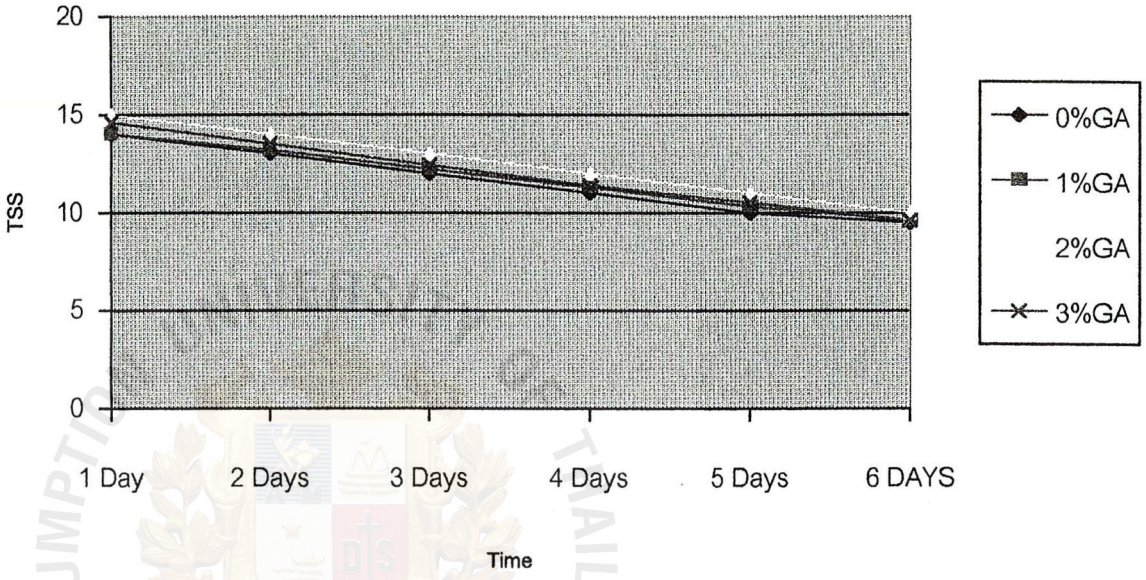


Figure 2. Changes in pH during fermentation

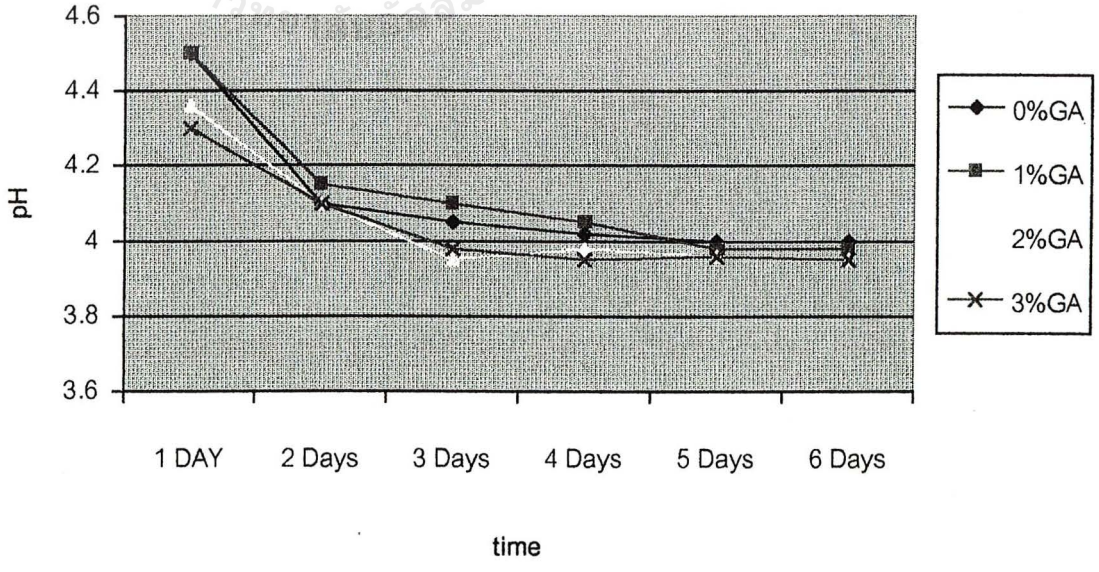


Figure 3. Changes in percentage of alcohol during fermentation.

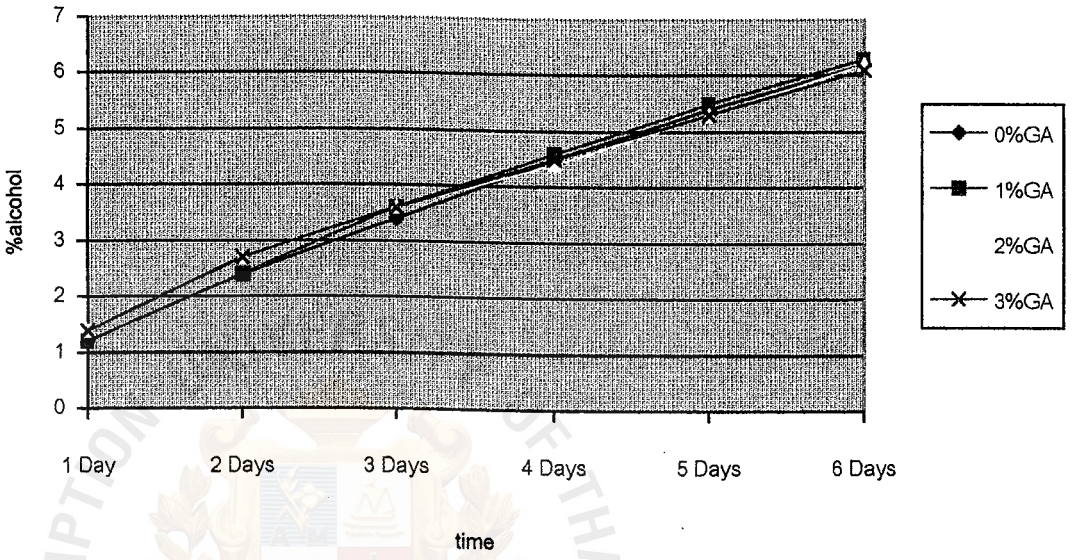


Figure 4.Changes in %TA during fermentation.

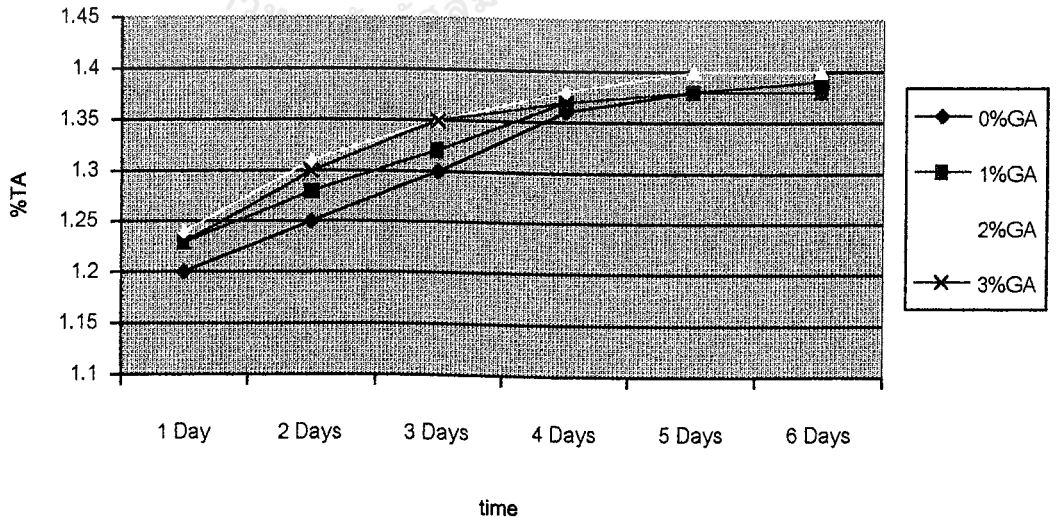
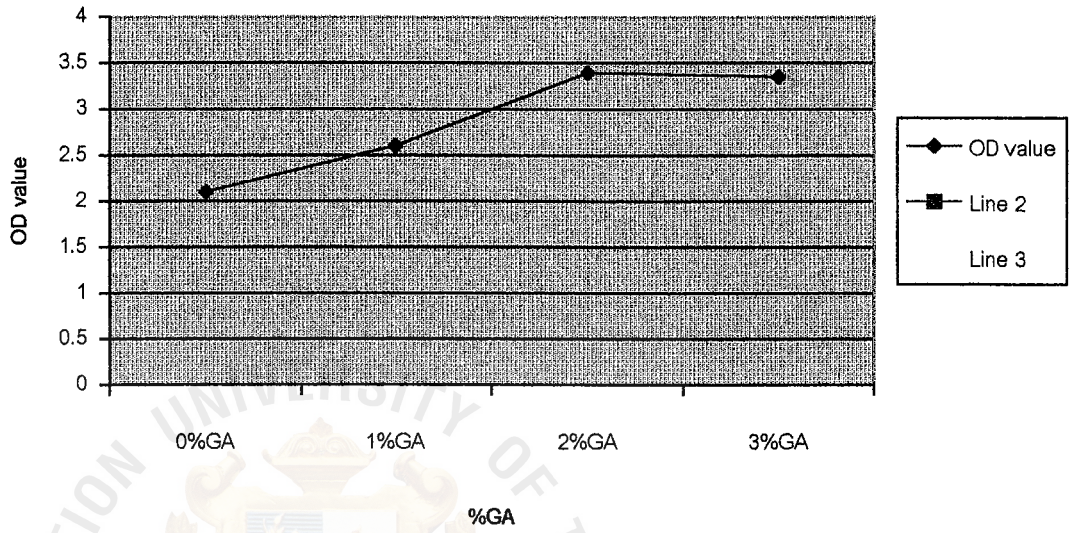
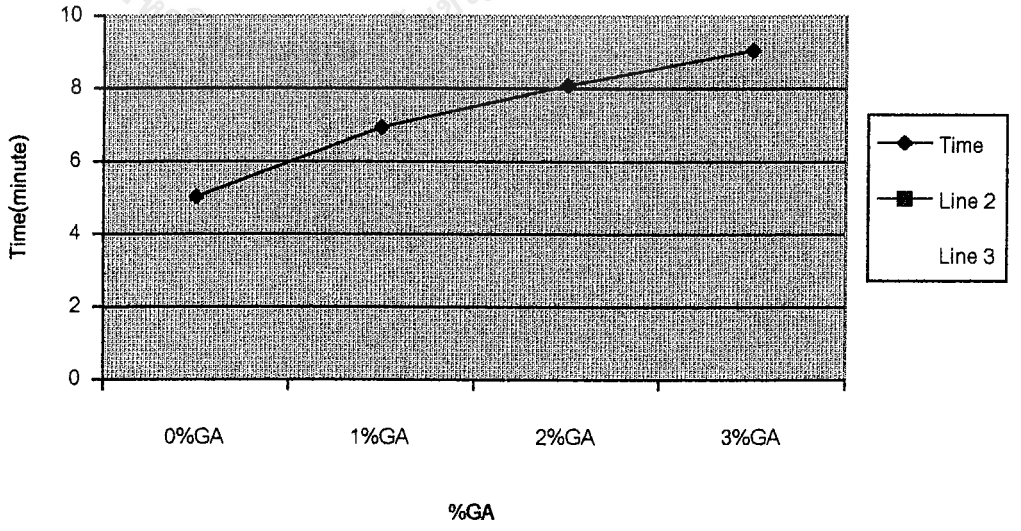


Figure 5.OD value at 380 nm.



Part 2 Measuring of foam stability

Figure 6. Time taken for foam dropping



Discussion

Figure 1-4, represented the changes of TSS, pH, % alcohol, and %TA during fermentation. The curves showed that gum arabic adding does not affect fermentation rate because the glycoprotein structure of gum arabic (Qi, W., Fong, C. & Lamport, 1997) does not participate in metabolism of yeast. Besides, gum arabic is fully soluble in water and insoluble in oil, propylene glycol and alcohol. So, there is on effect on percentage of alcohol.

Figure 5, represented for the Optical Density (OD) value of samples (0-3% gum arabic added) which were measured at 380 nm. OD value was increased when gum arabic was added because the protein parts of gum arabic were coagulated with tannin and form "protein-tannin" complex (ppt.) and resulted to increase turbidity (Blakely Paynter, 1996).

Figure 6. represented for beer foam stability of samples (0-3% gum arabic added) which were measured as time taken for foam dropping. The result showed that foam stability was increased when more gum arabic is added. Foam is formed due to the compounds in beer called glycoproteins, which are part hydrophilic and part hydrophobic. When many of these compounds gather on the top of beer, the hydrophobic parts group together in a circle create a pocket of CO_2, naturally forming bubbles (Alex Fodor, 1998). Then, more glycoproteins results more stable foam. Gum arabic is glycoprotein, increasing of gum arabic means increasing of glycoprotein. Then, foam is more stable.

Conclusion

Beer foam stability can be enhanced by adding gum arabic.

Recommendation

From the result of this research, although foam stability in beer can be enhanced, by adding gum arabic. But it also created another problem. That is the turbidity of beer has increased, this also open another aspect of research has to be done by the study of the possibility means of turbidity reducing in beer.

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Appendix

Preparation of wort

- Add malt extract into 5L water until TSS =12Bx.
- Heat until 80-90 C and keep temperature.
- Add bitter hop 15g. and stir for 1hr.
- Adding gum arabic(0-3% or 0, 50, 100, and 150g.).
- Add aroma hop 15g. and stir for 5min.
- Heat until boil and turn off fire.
- Whirlpool(slowly stir from outside to inside for 1 round)
- Cool down to room temperature.
- Rack into glass jar and close lid.
- Add KMS and shake well.
- Ready for inoculation.

Preparation for inoculation

- Pour 50ml. hot water into the beaker.
- Allowed to stand until temperature decreased to 35-40 C.
- Add dry yeast about half of spectular.
- Mix well.
- Ready for inoculation.

Calculation of total acid

$$\%\text{acidity} = \frac{\text{N of NaOH x Vol of NaOH x MW x 100}}{\text{Vol of sample x 100}}$$

Table 1. Properties of gum aracbic.

SOLUBILITY	Can yield solutions up to 55% concentration. Gum arabic is truly soluble in cold water.
VISCOSITY	Gum arabic is not very viscous, high viscosity is obtained only at concentration of 40-50%.
FILM -FORMING	Gum arabic's superb film-forming properties make it ideal for some confectionery coatings and lithographic plate solutions.
EMULSIFIER	Gum arabic produces highly stable emulsions making it very useful in the preparation of oil-in-water food flavour emulsions, particularly for citrus oils.
COLOR	Colorless (top quality) to pale straw color (average quality).
TASTE	Gum arabic has no off-taste. The taste of flavoring products co-spraydried with gum arabic is not affected or dulled by gum arabic as the carrier.
FIBER	Gum arabic can be regarded as 95% "soluble fiber", according to the latest evidence by nutritional experts.
C A L O R I C VALUE	Officially recognized in the U.S.A. as being under 1 Kcal per gram.
CHOLESTEROL REDUCER	Human dietary intake studies have indicated a reduction in blood cholesterol levels when above average amounts of gum arabic (25 grams per day) are ingested in solution.
TOXICOLOGICAL STATUS	"ADI not specified" (JEFCA+EEC); "Generally Recognized as Safe" (GRAS) (USA).

Table 2. Application of gum arabic.

Application	Function
Yogurts	Stabilizer
Poultry Products	Improve texture, moisture & flavor retention, improve freeze-thaw stability
Batter & Breading	Moisture retention, soluble fiber, crispness
Salad Dressing	Emulsifier, stabilizer
Caramels Toffees	Binder, fat distributor, chewiness improver
Candy	Emulsifier, sugar crystallization retarder
Frozen desserts	Stabilizer & texturizer
Gum Candies Sugared	Gum arabic-gelling agent
Bakery & Sweet Roll Glazing	Filmforming, improving sugar adhesion
Snacks	Adhesive, texture & flavor improver
Pastry dough	Thickener
Doughnuts Pies & Tarts icings	Neitral filmforming, glazing, moisture & oxygen barrier
Bakery Products	Baking improver, glazing stabilizer
Carbonated & Non-Carbonated soft Drinks	Improve emulsion stabilization of oil-in-water emulsion
Turbid Beverages	Turbidity & fiber
Ink	Suspension and Emulsifying agent
Ceramics	Binding and Glazing
Coated Pills "Dragees"	Coating filmforming
Compressed Tablets	Tableting, disintegrating mineral supplements