



Chelamax®

Magnesium: For a
Better Gummy

A Better Magnesium Gummy for Consumers

Consumers are increasingly becoming aware of the many benefits magnesium provides to the body. Magnesium is an essential mineral and electrolyte. It performs multiple physiological and biochemical functions—producing energy, regulating muscle and nerve function, blood sugar levels and blood pressure, and making proteins, bone, and DNA.¹ New evidence suggests that magnesium is also important for cognitive health, mood, stress, and sleep.^{2,3,4,5}

Growing consumer interest has led dietary supplement manufacturers to launch magnesium-based products in new, more appealing formats. Gummies are the fastest growing supplement format—with vegan pectin-based gummies overtaking gelatin gummies in North America. However, dietary supplement manufacturers face many challenges using magnesium in formulations involving pectin: failure to set properly and unpleasant texture (e.g., stickiness) in the finished product.

Chelamax® Magnesium Citrate allows for proper setting, pleasing texture, and higher mineral potency in vegan gummies.

To identify a solution, Innophos conducted a study comparing different sources of magnesium in a pectin-based format. Results from this study are found in this whitepaper which covers:

- **Market drivers for vegan and vegetarian gummies**
- **The setting properties of Chelamax® Magnesium Citrate compared to USP magnesium citrate and magnesium citrate anhydrous**
- **The texture of gummies made with Chelamax® minerals compared to commercially available samples**



Demand for Magnesium Gummies

During the last two years, magnesium dietary supplement sales have risen 13.1%, growing at an even faster rate than zinc, which experienced unprecedented growth during the pandemic.⁶ The Council for Responsible Nutrition's⁷ (CRN; Washington, DC) latest Consumer Survey on Dietary Supplements, conducted on more than 3,100 U.S. adults in August 2022, ranked magnesium as one of the top-10 dietary supplements U.S. consumers take. In the survey, 21% of supplement users surveyed said they take magnesium.

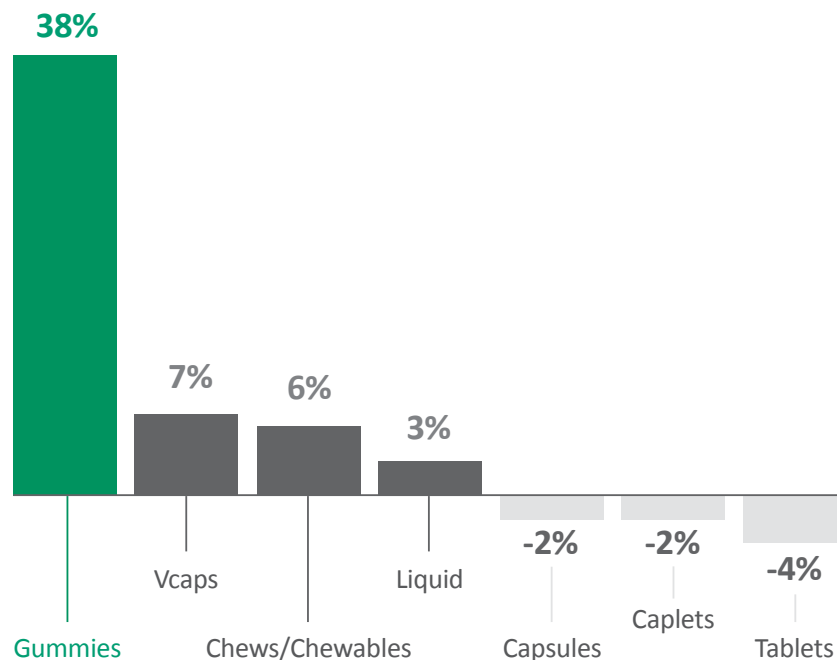
Gummy formats are experiencing the fastest growth due to their appeal to consumers of all ages. New product launches of vitamin/mineral gummy supplements have exploded in North America with a 38% CAGR (2017-2021) compared to other supplement formats as shown in Figure 1.⁸

Two popular gelling agents for formulating gummies are gelatin (processed protein of collagen extracted from animals) and pectin (a plant-based polysaccharide, which provides a vegetarian alternative).⁹

Consumers seeking plant-based/vegan products have driven the growth of pectin-based gummies. Indeed, in 2021, pectin was the most popular gelling agent in global launches of dietary supplement gummies.¹⁰ Vegan and no animal ingredient claims in vitamin and mineral supplements rose by over 47% in 2021.¹⁰

As the usage of this plant-based polysaccharide has continued to increase, it has come with a host of challenges for formulators looking to transform different mineral compounds into gummy form.

Figure 1: Vitamin/Mineral Growth Rates by Format – CAGR (2017-2022)



Source: Innova Market Insights

Formulating with Magnesium

There are many challenges associated with formulating with magnesium. First, many sources of magnesium have a high pH, making them less soluble and poorly suited for gummies. Additionally, these sources tend to have low values of magnesium and require consumers to take many gummies to meet the relatively high recommended intake of up to 420 mg of magnesium per day. To address consumers' desire to minimize the number of gummies per dose, the industry is seeking higher magnesium levels in gummies.¹² Innophos offers magnesium sources which are stable, soluble, and in the correct pH range for the desired gummy setting. Magnesium citrate is a preferred source of magnesium due to its good solubility and pH in the acidic range, a necessity for any setting agent.

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Pectin Gummy Study

We compared three sources of magnesium citrate: Chelamax® Magnesium Citrate, USP grade and a commercial anhydrous USP grade. The seemingly small differences in these magnesium sources have a major influence on the setting of pectin in the gummy.

Gummy prototypes were made using a typical formulation shown in Table 1.

Table 1: Typical Pectin-Gummy Formulation:

INGREDIENT	TYPICAL RANGE
Sugars	60-80%
Water	10-20%
Magnesium Citrate	11-17%
Pectin	3-7%
Citric Acid	1-3%
Flavor	1%

Magnesium was added using the three magnesium citrate sources with an initial goal of about 60 mg magnesium in a 3 g gummy. Magnesium gummies containing 20 mg per gram are available on the market today, so this magnesium level was used as a benchmark for testing. The addition of Chelamax® Magnesium Citrate resulted in the successful formation of a gummy. However, the addition of both magnesium citrate USP or magnesium citrate anhydrous failed to form a gummy—these gummies did not set properly. See Figure 2.

Increasing the level of magnesium to 42 mg of magnesium per gram of gummy (126 mg/gummy), which is well above the average concentration available today, resulted in a well-formed gummy when Chelamax® Magnesium Citrate was used. Using the other two sources of magnesium citrate resulted in a gummy that did not set. The differences in the magnesium source used was a factor in the setting of the gummy.

Key Findings:

- Chelamax® Magnesium Citrate exhibits **higher loading levels** than many commercially available products.
- Chelamax® Magnesium Citrate is **more stable** than other sources with no mass gain via moisture absorption when exposed to excess relative humidity.
- Chelamax® Magnesium Citrate produces pectin-based gummies with **pleasing texture** while other magnesium citrate sources could not.
- Pectin-based gummies containing Chelamax® Magnesium Citrate are **less sticky**, exhibiting minimal tooth packing compared to control and thus offering a better sensorial experience for the consumer.

Figure 2: Comparison of Gummies with 60 mg of Magnesium per Gummy



One explanation for why Chelamax® Magnesium Citrate is so effective in a pectin-based system is that it is a fully chelated compound, so there is no release of free magnesium ions to react with pectin in the formulation. Pectin is a polysaccharide with cation-binding capacity. As pectin comes in contact with free positively charged ions, such as magnesium, the interaction could cause a disruption in the pectin’s ability to set.

Table 2 compares properties of the magnesium citrate used in these studies. All three sources had different percentages of magnesium.

- **pH** – Chelamax® Magnesium Citrate has a lower pH, closer to the setting range for pectin, so less pH adjustment is needed in the formula.
- **Loss on drying** – The loss of mass on drying of 0.8% shows that while Chelamax® Magnesium Citrate is hydrated, the water is bound in the structure and not freely available for reaction.
- **Moisture absorption** – Moreover, data obtained from sorption isotherms shows that when subjected to an elevated humidity of 90% relative humidity (RH), Chelamax® Magnesium Citrate does not gain mass.

Table 2. Properties of Different Sources of Magnesium Citrate

SOURCE	MAGNESIUM %	pH	LOSS ON DRYING	MOISTURE ABSORPTION
Chelamax® Magnesium Citrate	11.7%	5.7	0.8%	0.0%
USP Magnesium Citrate	14.5%	6.6	9.3%	4.3%
Magnesium Citrate Anhydrous	16.1%	6.1	0.8%	24.1%

This indicates that the product is stable, and it will not interact with free water from the gummy system in formulation or over the shelf life of the product. The anhydrous sample, as expected, absorbed the most water, with a gain in mass of over 24%.

Chelamax® Gummies: The Importance of Texture

Once we demonstrated the ability of Chelamax® Magnesium Citrate to achieve properly set pectin gummies, we compared the texture of Chelamax® gummies, at two different potencies (60 mg and 126 mg), to commercially available mineral supplements.

The texture of a gummy is as important as reaching the desired mineral content.

To make this comparison, we created an “average texture profile” by analyzing five commercially available mineral supplement gummies. The samples we chose did not exclusively use pectin as the setting agent, but all contained at least one mineral in their formulation.

Texture is important because it affects the gummy’s organoleptic properties (including “mouth feel” and chewiness). Gummies that are too firm or too sticky may be experienced by consumers as unsatisfying, and they may switch to a different brand.

The texture profile for the gummies containing Chelamax® Magnesium Citrate was within the range of both firmness and pH of the commercially available brands, as shown in Table 3.

Both firmness and stickiness are related to bite or chew properties of the gummy (e.g., if the gummy is too firm, it will be difficult to chew). When measuring stickiness,

the more negative values are considered stickier. Stickier gummies will adhere to teeth, known as tooth packing, while the user chews and become difficult to remove.

Water activity (a measure of free water in the system) can negatively affect the stickiness and overall shelf life of the gummies. In these studies, we found that the gummies containing Chelamax® Magnesium Citrate showed lower water activity and were less sticky than the commercial gummies, offering a more pleasant mouth feel while still within the normal firmness range. Moreover, the lower water activity in Chelamax® Magnesium Citrate containing gummies (less than 0.6) could reduce the chance of microbial growth, including mold.

Table 3. Texture and Other Parameters of Gummies Containing Magnesium

SAMPLE	pH	a _w	FIRMNESS (g)	STICKINESS (g)
Texture Profile (range)	3.1-4.6	0.68-0.71	77-400	-370 to -125
Chelamax® Magnesium Citrate (60 mg gummy)	3.4	0.56	90	-64
Chelamax® Magnesium Citrate (126 mg gummy)	3.4	0.51	168	-168

Overall, this is a good indication that Chelamax® Magnesium Citrate has a positive effect on the organoleptic properties of gummies. Furthermore, the Chelamax® brand was the only magnesium citrate that formed a fully set gummy in the pectin-based system.



Conclusion

We tested three forms of magnesium citrate for suitability in producing pectin-based gummies. We selected these forms based on their pH and solubility. In the end, only the Chelamax® Magnesium Citrate formed a gummy that properly set; the other two sources failed to successfully create gummies. A comparison of the three sources also showed Chelamax® Magnesium Citrate has low free water, low loss in drying, and is not susceptible to relative humidity changes. The other samples were not as stable in regards to free water and humidity.

Chelamax® Magnesium Citrate is the clear choice for a better gummy supplement. It is more stable, less sticky, and the only source in our testing that was able to form consistent gummies with a pleasing texture profile at higher magnesium levels in a pectin-based system.

Innophos is committed to supplying the dietary market with the highest quality, science-backed minerals in the industry. We continue to share evidence of the superior performance of our verified chelated minerals.

Chelamax® Magnesium Citrate is the clear choice for a better gummy supplement.



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