



Glycerol – what is it? What can it do for you?

Jose Antonio, PhD, CSCS

Glycerol, also known as glycerin, is a sweet, syrupy, colorless liquid that is used as a sweetener by the food industry. If you pull out your dust-covered biochemistry books, you'll notice that much of the discussion of glycerol deals the fact that it's an integral component of the triglyceride (fat) molecule. In fact, glycerol forms the backbone of the triglyceride molecule. So does that make glycerol a fat? Mmm...Read on.

For instance, in your fat cells and from dietary fat, glycerol can be "made" simply by chopping the triglyceride molecule into bits and pieces. The end result, a glycerol molecule and some free fatty acids. Now that you've liberated glycerol from the clutches of fatty acids, what does glycerol become? A fat? A carbohydrate? Or maybe it really doesn't fit into any neat category.

If you go by how chemistry books define carbohydrates and glycerol, you'll see that fitting glycerol into the carbohydrate category is like putting a baseball player on a football field...the fit just ain't there! For instance, according to a well-known biochemistry textbook "Carbohydrates are polyhydroxy aldehydes or ketones, or substances that yield such compounds on hydrolysis."¹ Glycerol (1,2,3-propanetriol) is defined as a naturally occurring trivalent alcohol. Glycerol oxidation yields 4.32 kcals per gram when oxidized to carbon dioxide and water.² So even though the number of calories in carbohydrates and glycerol are the same, structurally, they aren't the same. Besides, proteins and carbohydrates have a similar caloric value also.

Glycerol ingestion does not affect resting plasma glucose or insulin

Another interesting aspect of glycerol is whether it contributes substantially to the formation of glucose, a process scientists call gluconeogenesis. If you starve yourself for 3-4 days, then glycerol might contribute a bit to glucose production (about 22% of total glucose production). But if you don't starve yourself...and you should be shot (figuratively speaking) if you do, then in that case, glycerol doesn't contribute much at all (less than 5% of total glucose production).³

Also, when you consume glycerol, even in amounts that could service a gorilla, you don't get a change in blood glucose and insulin. For instance, in a study published in the *European Journal of Applied Physiology*⁴, they examined six healthy, non-obese men (32 yrs of age on average) during exercise to exhaustion on a cycle ergometer (73% of $\dot{V}O_{2max}$) after the ingestion of glucose, glycerol, or placebo. The ingestion of glucose (1 gram per kg body weight; equal to 70 grams for a 150 lb person) 45 minutes prior to exercise produced a 50% increase in plasma glucose as well as a 3-fold increase in plasma insulin at zero minutes of exercise. On the other hand, glycerol consumption (1 gram per kg body weight) 45 minutes prior to exercise produced a 340-fold increase in plasma glycerol; but resting levels of plasma glucose and insulin did not change.

OK, Dr. Antonio, but who gives a hoot if glucose and insulin doesn't change? The answer? The glycemic index. Many studies indicate that consuming a high-carbohydrate diet could elevate plasma triglycerides and adversely affect LDL

(increase the “bad” cholesterol) and HDL (decrease the “good” cholesterol) levels. Also, eating carbohydrates, especially the high glycemic index [GI] variety (i.e., provoke a sharp rise in plasma glucose and subsequently insulin) can have detrimental effects on body weight and blood lipids. For instance, voluntary food intake after a high GI meal was 81% greater than after a low GI meal.⁵ In addition, a high dietary glycemic load can also increase the risk of coronary heart disease (CHD).⁶

Now if you substitute glycerol for high-glycemic carbohydrates, it would make sense that this might minimize the plethora of health problems associated with eating cookies and cakes. Glycerol has little if any effect on resting plasma glucose and insulin at rest; at that’s after taking whopping doses.

Glycerol as an ergogenic aid

Because of glycerol enables you to retain more fluid, some scientists theorize that taking exogenous glycerol might help performance. This is based on the fact that if you keep yourself well-hydrated, then you’ll be able to train harder and longer, particularly in hot environments. According to Dale Wagner, Ph.D. of Vanguard University of Southern California, “Most likely glycerol has the greatest benefit in athletes participating in ultraendurance sports conducted in hot, humid conditions where threat of dehydration is the greatest.”⁷ Like with all science, there isn’t a unanimous consensus on glycerol’s effects.

However, an intriguing study published in the International Journal of Sports Medicine showed the potential that glycerol might have as an ergogenic aid.⁸ The effects of glycerol ingestion (1.2 gm/kg glycerol in a 20% solution plus water) compared to pre-exercise placebo hydration (PH) (26 ml/kg of aspartame flavored water) was determined during cycling exercise to exhaustion. Taking glycerol produced a lowered heart rate and increased time to exhaustion by over 20% during submaximal load cycle ergometry. So at least in this instance, glycerol was shown to be beneficial.

Take home message

- ✓ Glycerol does not fit the structural definition of a carbohydrate.
- ✓ Exogenous glycerol ingestion does not produce significant increases in plasma insulin or glucose.
- ✓ Glycerol might improve endurance exercise performance in the heat.

References

1. ¹ Lehninger, A.L., D.L. Nelson, and M.M. Cox. Principles of Biochemistry, 2nd edition, Worth Publishers, New York, 1993.
2. ¹ Frank, M.S.B., M.C. Nahata, and M.H. Hilty. Glycerol: A review of its pharmacology, pharmacokinetics, adverse reactions, and clinical use. *Pharmacotherapy*. 1:147-60, 1981.
3. ¹ Baba, H., X-J, Zhang, and R.R. Wolfe. Glycerol gluconeogenesis in fasting humans. *Nutrition*. 11:149-153, 1995.
4. ¹ Gleeson, M., R.J. Maughan, and P.L. Greenhaff. Comparison of the effects of pre-exercise feeding of glucose, glycerol, and placebo on endurance and fuel homeostasis in man. *European Journal of Applied Physiology*. 55:645-653, 1986.
5. ¹ Ludwig, D.S. et al. High glycemic foods, overeating, and obesity. *Pediatrics*. 103:E26, 1999.
6. ¹ Liu, S. et al. A prospective study of dietary glycemic load, carbohydrate intake, and risk of coronary heart disease in US women. *American Journal of Clinical Nutrition*. 71:1455-61, 2000.

7. ¹ Wagner, D.R. Hyperhydrating with glycerol: implications for athletic performance. *Journal of the American Dietetic Association*. 99:207-212, 1999.
8. ¹ Montner, P. et al. Pre-exercise glycerol hydration improves cycling endurance time. *International Journal of Sports Medicine*. 17:27-33, 1996.

RunFast SUMMARY

Glycerol

What is it? Also called glycerin, glycerine, or 1,2,3-propanetriol; it is a colorless, odorless, sweet-tasting, syrupy liquid.

What does it do? Is used in the food industry to improve moisture, palatability, and as a sweetener.

How many calories does it have? About 4 kcals per gram

What is the most commonly used dose (as an ergogenic aid)? Roughly ½ gram per lb. Much lower doses are used in sport bars.

References:

- ¹ Lehninger, A.L., D.L. Nelson, and M.M. Cox. Principles of Biochemistry, 2nd edition, Worth Publishers, New York, 1993.
- ² Frank, M.S.B., M.C. Nahata, and M.H. Hilty. Glycerol: A review of its pharmacology, pharmacokinetics, adverse reactions, and clinical use. *Pharmacotherapy*. 1:147-60, 1981.
- ³ Baba, H., X-J, Zhang, and R.R. Wolfe. Glycerol gluconeogenesis in fasting humans. *Nutrition*. 11:149-153, 1995.
- ⁴ Gleeson, M., R.J. Maughan, and P.L. Greenhaff. Comparison of the effects of pre-exercise feeding of glucose, glycerol, and placebo on endurance and fuel homeostasis in man. *European Journal of Applied Physiology*. 55:645-653, 1986.
- ⁵ Ludwig, D.S. et al. High glycemic foods, overeating, and obesity. *Pediatrics*. 103:E26, 1999.
- ⁶ Liu, S. et al. A prospective study of dietary glycemic load, carbohydrate intake, and risk of coronary heart disease in US women. *American Journal of Clinical Nutrition*. 71:1455-61, 2000.
- ⁷ Wagner, D.R. Hyperhydrating with glycerol: implications for athletic performance. *Journal of the American Dietetic Association*. 99:207-212, 1999.
- ⁸ Montner, P. et al. Pre-exercise glycerol hydration improves cycling endurance time. *International Journal of Sports Medicine*. 17:27-33, 1996.