

TRANSGLUTAMINASE IN FOOD ADULTERATION AND PERSPECTIVES OF SUSTAINABLE DEVELOPMENT

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Abstract. Transglutaminase is widely used in all branches of the food industry because it has modeling properties, improves the appearance of the texture, increases the total weight of the product and extends the shelf life. Most often, a positive opinion is formed only among manufacturers who on an industrial scale use enzymes for the preparation of products in order to increase the profitability of production. Transglutaminase is also used for replacement preservatives, emulsifiers, stabilizers, flavors, dyes, and sweeteners because it's still allowed in Ukraine, Although the information about the enzyme, regardless of its origin, provides information that it withstands heat, does not spoil and is completely safe, but there is no exact information on the product labels, which type of transglutaminase was used, and its presence is not indicated at all. Such information should not be secret, manufacturers, on the contrary, should inform consumers about their products and guarantee their quality and safety. Most of the information on the product labels is written in a complicated way using an abbreviation that is not decoded and is not understandable for buyers, this is one of the ways of manufacturers to avoid responsibility. All this leads to the aggravation of the global problem of falsification of food products and to the tricks of manufacturers to constantly replace one component with another under the guise of the beneficial properties of some additives that are not prohibited in the food industry and approved in many countries of the world.

Keywords: Transglutaminase, Microbial transglutaminase (mTG), enzyme, food industry, manufacturers, consumers, European Parliament,

Introduction. The famous phrase «We are what we eat » was said by the ancient Greek physician Hippocrates, who believed that food in human life plays important role because as it is source of energy and happiness. It is hard not to agree with this but how to be when food which consumed by a person in the XXI century contains less and less useful and natural ingredients due to the constant desire to profit from manufacturers who produce large quantities of adulterated products for a large profit. Nowadays the most valuable component for manufacturers is considered

Transglutaminase (TG) also known as thrombin or meat glue. It was first developed and implemented in the food industry in Japan in 1959 by the company «Ajinomoto» under the trade name Activa. Buckwheat noodles and crab meat are the first products that were created based on Transglutaminase. Now use of enzymes has gained significant demand not only for the preparation of crab meat and in molecular cuisine restaurants which are not ashamed demonstrated properties TG for non-traditional cooking dishes. However, assuring consumers that transglutaminase is completely safe, as it is a catalyst that forms isopeptide bonds between proteins, thanks to which you can literally glue together meat, seafood, fish, and dairy products [10,11]. But that's problem that glued products together from different pieces or from industrial waste look like they have just been prepared and are sold at a higher price than they should be.

Thus, perceiving the fact of falsification of TG products, we increasingly become dependent on the consumption of low-quality products that are part of our diet [1-3].

The goal of our work — investigate how widespread TG is in the food industry in Ukraine and whether manufacturers always inform consumers about the presence of TG in their products

TG is used not only as a food additive but for development of drugs and increasing synergy of probiotics. One example is prothrombin which is extracted from blood cows, chickens, and pigs but the function of that TG as better known as factor XIIIa (fibrin-stabilizing factor) A-chain, etc.

The role of such TG is the formation of biological polymers, which are necessary for the body to create barriers and stable structures (clot formation, blood coagulation). Also obtained from plants and plant extracts (for growth and development of plant) and microorganisms family *Streptomyces spp.*, exactly this species of TG was obtained from *Streptomyces mobaraensis* is a calcium-independent enzyme used for catalysis as a cofactor and to increase the bioavailability of probiotics

Combination of soy isolate with transglutaminase improves the passage of probiotics and prebiotics through the stomach to the lower intestines [14-15]. Beside this, transglutaminase is increasingly used in food industry. But most manufacturers do not indicate the detailed chemical composition of the product since this information is not required from them.

Before displaying all the negative aspects of using transglutaminase, let's list the positive ones.

For main properties of the enzyme include:

- improving the consistency of finished products;
- increasing the juiciness and improving the elasticity of products;
- increase in output of final products;
- ensuring stable quality;

- reduction of moisture loss (when storing the product in cut or packaged form);
- use of the minimum dosage of transglutaminase (provided due to the high technological activity of the additive).

Microbial transglutaminase (mTG).

It is considered safer than other species because it has higher binding properties than aTG of plasma and erythrocytes produced by microorganisms *Streptovorticillium moboarense* which affects of the functional properties of protein in food products at the molecular level. TG is a biocatalyst of reactions between protein and peptide molecules, which determine the impact on important physicochemical properties of proteins (hydrophobicity, gelation, etc.).

Therefore, the use of TG makes it possible to reduce a large number of other ingredients in recipes - carrageenans, gums, phosphates, emulsifiers, etc. [4].

Usage of transglutaminase in different branches of the food industry in the Ukrainian

It is added to minced meat and cooked sausages in the meat industry. TG contributes to the formation of a protein mesh structure, between the cells of which moisture and fat are retained. But for this, a certain concentration of the protein is required it might be at list than 12% in the minced meat. At the same time, the nature of the protein can be any. More often is usage, in the case of meat glue is for gluing different pieces of meat into one to give it the shape of a solid piece of meat (Fig.1,2)



Fig.1 Meat created on the basis of transglutaminase



Fig.1 Crab meat is created on the basis of fish waste with the help of transglutaminase

It can be a vegetable, milk, muscular (myoglobin), or collagen protein. It's important to understand that transglutaminase is a biocatalyst that ensures the bidding proteins due to cross-links between amino acids lysine and glutamine [9].

Dairy industry — for the increase of 10-15% in finished product due to the transfer of most of the whey proteins, the improvement of the texture of the creamy taste and physical properties with a decrease in the cost of the finished product.

For storing vegetables and fruits — whey protein is modified by microbial transglutaminase (TGase) is used to create protein film for vegetables and fruits which are processed to improve their freshness and extend their shelf life (Porta et al., 2015). One of the most important functions of edible coating is to protect fruits from moisture loss, improve and extend their shelf life, and less reduction of losses associated with transportation, distribution, and long-term storage on trade shelves. Edible films have been used since 1980. Only 10 companies producing vegetables, fruits and dried fruits provided such services. Today's use of edible films spreads quickly with annual sales exceeding 100 million US dollars (Pavlath & Orts, 2009).

Bakery products — for ion-binding capability of protein no gluten species of flour (rice, corn) with the purpose for the increase gluten aggregation of different kinds of protein flours and improving the technical potential of flour as row bakery and pasta production. Besides this during bakery bread is possible to product moisture retention without less mass fraction. Also, used during freezing dough because consistency is more greatly stable to dehydration is related to the process of freezing (Kim et al., 2008).

Transglutaminase is widely used in all fields of the food industry because it has modeling properties of improving upper appearance texture, increasing the general mass of products, and extending the shelf life. However, most often, only manufacturers have a positive opinion about TG.

Consumers are mostly unaware that they are consuming products containing TG.

We set ourselves the goal of investigating how widespread TG is in the food industry in Ukraine and whether manufacturers always inform consumers about the presence of TG in their products.

With the help of organoleptic studies, which involve standard methods of evaluating the quality of a product using the senses, it is difficult to establish the presence of TG in cheese, milk, yogurt, etc. Most authors state that TG has no side effects and does not spoil, but more and more information is emerging about the occurrence of diseases caused by excessive consumption of composite products. Recently, the detection of serological markers of microbial and tissue TG, which bind gliadin with the formation of antibodies to mTG-neo and neo-tTG, is a well-known fact of celiac disease [16, 17].

According to (De Jong et al., 2002; Gharibzahedi et al., 2018) is most often used in the food industry exactly microbial transglutaminase it can suppress the body's defense mechanisms and mimic other types of human transglutaminase, causing chronic human diseases. In contrast, *Lerner; A. Amirdivani et al., 2018* believe that diagnosed diseases in children in the age range of 6-7 years

include celiac disease, dermatitis herpetiformis, and gluten ataxia. The etiology of these diseases is related to epidermal transglutaminase, which acts as a trigger for damage to the epithelium. Based on the above adverse effects, regulatory and food safety authorities should review the status of transglutaminase as a food aid that should be labeled and carefully evaluated for toxicity and health safety, as there is no clear information on product labels which exactly type TG was used and its presence is not indicated at all. Most of the information on product labels is written in a complicated and incomprehensible manner for the buyer. This is one of the ways manufacturers avoid responsibility. In EU countries, food manufacturers must provide detailed information about the composition of their products so that consumers can make an informed decision to consume the products or not. Thus, the consumer in the EU is protected from potential unscrupulous actions of market operators [7].

In addition, the European Parliament banned the use of transglutaminase or meat glue and repealed the resolution recitation 25 of the draft Commission Directive on the introduction of thrombin-based enzyme into food additives, since the purpose of TG is to bind individual pieces of meat to obtain a single meat product, and therefore the risk of misleading the consumer is obvious [12].

64 years have passed since the isolation of TG, during this period a lot of different information was found about the positive and negative consequences for human health, which manifest themselves as poisoning, allergic reactions, malabsorption syndrome, problems with the pancreas, etc.

Until recently, TG was used as a therapeutic agent to enhance the expression of blood cells (erythrocytes), but this information was refuted by the authors *T. Matthias, P. Jeremias, S. Neidhöfer, et al* [6], instead, TG is able to cross-link many proteins and other macromolecules, changing their structure, composition, antigenicity, physical and chemical characteristics, which leads to an increase in the load on the intestinal lumen of the immune system [7-8].

From this review, it is difficult to draw a conclusion about the positive or negative effect of transglutaminase. Rational use always allows you to prevent negative consequences and addiction, but only in those cases where clear norms, rules and laws are prescribed.

Conclusion: Without any doubt usage of transglutaminases in the food industry has a number of advantages, because it improves organoleptic indicators, increases the effectiveness of food production, and allow to creation of new product. Despite the benefits of transglutaminase for replacement preservatives, emulsifiers, stabilizers, flavors, dyes, and sweeteners, it's still allowed in Ukraine, and therefore contributes to the enrichment of manufacturers who continue to sell counterfeit products on an industrial scale to the market, reducing the health of the population. But the problem is that glued products from different pieces or from industrial waste look like they have

just been prepared and are sold at a higher price than they should be. Reassuring consumers that there is no harm in consuming such products still leaves the question open.

References

1. Beauty Women. Гіппократ про здоров'я: цитати, які потрібно знати кожному. Available at <https://bt-women.com.ua/health/gippokrat-o-zdorove-tsitaty-kotorye-nuzhno-znat-kazhdomu>
2. Бахмут Н. Формування здорового способу життя та фізичний розвиток молодших школярів у новій українській школі. Кам'янець-Подільський національний університет імені Івана Огієнка. № 3 (107) 2021. Available at <https://pedscience.sspu.edu.ua/wp-content/uploads/2021/11/33.pdf>
3. Caroline Howard. Names You Need To Know: Meat Glue. Yum Or Yuck? May 13, 2011. Available at <https://www.forbes.com/sites/carolinehoward/2011/05/13/names-you-need-to-know-meat-glue-yuck-or-yum/?sh=198bbd615682>
4. Debris C, Chazelas E, Srouf B, Druesne-Pecollo N, Esseddik Y, Szabo de Edelenyi F, Agaësse C, De Sa A, Lutchia R, Gigandet S, Huybrechts I, Julia C, Kesse-Guyot E, Allès B, Andreeva VA, Galan P, Hercberg S, Deschasaux-Tanguy M, Touvier M. Artificial sweeteners and cancer risk: Results from the NutriNet-Santé population-based cohort study. *PLoS Med.* 2022 Mar 24;19(3):e1003950. doi: 10.1371/journal.pmed.1003950. PMID: 35324894; PMCID: PMC8946744.
5. Butchko, H; Stargel, WW; Comer, CP; Mayhew, DA; Benninger, C; Blackburn, GL; De Sonneville, LM; Geha, RS та ін. (2002). Aspartame: Review of Safety. *Regulatory Toxicology and Pharmacology* 35 (2 Pt 2): S1–93. PMID 12180494. doi:10.1006/rtp.2002.1542.
6. Matthias T, Jeremias P, Neidhöfer S, Lerner A. The industrial food additive, microbial transglutaminase, mimics tissue transglutaminase and is immunogenic in celiac disease patients. *Autoimmun Rev.* 2016 Dec;15(12):1111-1119. doi: 10.1016/j.autrev.2016.09.011. Epub 2016 Sep 15. PMID: 27640315
7. Matthias T, Jeremias P, Neidhöfer S, Lerner A. The industrial food additive, microbial transglutaminase, mimics tissue transglutaminase and is immunogenic in celiac disease patients. *Autoimmun Rev.* 2016 Dec;15(12):1111-1119. doi: 10.1016/j.autrev.2016.09.011. Epub 2016 Sep 15. PMID: 27640315.
8. Які товари з України заборонені для ввезення в країни ЄС: повний список. Available at <https://sud.ua/uk/news/abroad/268203-kakie-tovary-iz-ukrainy-zaprescheny-dlya-vvoza-v-strany-es-polnyy-spisok>

9. “Токсичний для людей: Євросоюз заборонить в продуктах поширених харчовий барвник серії «Е».” <https://www.ukrinform.ua/rubric-world/3329936-toksicnij-dla-ludej-evrosouz-zaboronit-v-produktah-posirenij-harcovij-barvnik-serii-e.html> (accessed May 28, 2023).
10. Calcaterra V, Regalbuto C, Manuelli M, Klersy C, Pelizzo G, Albertini R, Vinci F, Larizza D, Leonard MM, Cena H. Screening for celiac disease among children with overweight and obesity: toward exploring celiac iceberg. *J Pediatr Endocrinol Metab.* 2020 Jul 13;/j/jpem.ahead-of-print/jpem-2020-0076/jpem-2020-0076.xml. doi: 10.1515/jpem-2020-0076. Epub ahead of print. PMID: 32653877.
11. Anami Y, Tsuchikama K. Transglutaminase-Mediated Conjugations. *Methods Mol Biol.* 2020;2078:71-82. doi: 10.1007/978-1-4939-9929-3_5. PMID: 31643050.
12. Deweid L, Avrutina O, Kolmar H. Microbial transglutaminase for biotechnological and biomedical engineering. *Biol Chem.* 2019 Feb 25;400(3):257-274. doi: 10.1515/hsz-2018-0335. PMID: 30291779.
13. European Parliament. MOTION FOR A RESOLUTION on the draft Commission directive amending the Annexes to European Parliament and Council Directive 95/2/EC on food additives other than colours and sweeteners and repealing Decision 2004/374/EC/ Available at https://www.europarl.europa.eu/doceo/document/B-7-2010-0264_EN.html?redirect
14. Yew, S.E.; Lim, T.J.; Lew, L.C.; Bhat, R.; Mat-Easa, A.; Liong, M.T. Development of a probiotic delivery system from agrowastes, soy protein isolate, and microbial transglutaminase. *J. Food Sci.* 2011, 76, H108–H115.
15. Lerner A, Benzvi C. Microbial Transglutaminase Is a Very Frequently Used Food Additive and Is a Potential Inducer of Autoimmune/Neurodegenerative Diseases. *Toxics.* 2021 Sep 25;9(10):233. doi: 10.3390/toxics9100233. PMID: 34678929; PMCID: PMC8537092.
16. Matthias, T.; Lerner, A. Microbial Transglutaminase Is Immunogenic and Potentially Pathogenic in Pediatric Celiac Disease. *Front. Pediatr.* 2018, 6, 389.
17. Agardh D, Matthias T, Wusterhausen P, Neidhöfer S, Heller A, Lerner A. Antibodies against neo-epitope of microbial and human transglutaminase complexes as biomarkers of childhood celiac disease. *Clin Exp Immunol.* 2020 Mar;199(3):294-302. doi: 10.1111/cei.13394. Epub 2019 Nov 11. PMID: 31663117; PMCID: PMC7008223.