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THE IMPORTANCE OF FOOD ADDITIVES IN THE MANUFACTURE OF MEAT PRODUCTS[1]

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Summary

THE IMPORTANCE OF FOOD ADDITIVES IN THE MANUFACTURE OF MEAT PRODUCTS[1/]

G. M. Lippmann*

The main groups of additives in the manufacture of meat and the way they work are described. Salt (sodium chloride) is introduced not only as a flavouring matter but also to increase the ionic strength for salt-solubility of actomyosin. Nitrite and Nitrate are added for their preservative and colour-developing properties. Polyphosphates have a wide spectrum of functions in meat manufacture, including pH stabilization and improving the physical properties of meat. The addition of milk and vegetable proteins contributes to a high emulsion stability, especially in canned meats. Binders, fillers and thickeners are valuable additives especially in tropical countries to increase the water-holding capacity and improve the texture of meat goods. The final chapter gives details about the curing mechanism.

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Colloque sur les perspectives du traitement industriel de la viande dans les pays en voie de développement

Vienne (Autriche), 13-17 octobre 1975

RESUME

L'IMPORTANCE DES ADDITIFS DANS LA FABRICATION DES PREPARATIONS DE VIANDE 1/

par
G.M. Lippmann*

L'étude décrit les principaux groupes d'additifs utilisés dans les préparations de viande et la façon dont ils agissent. Le sel (chlorure de sodium) ne sert pas seulement à assaisonner mais aussi à accroître la force ionique qui agit sur la solubilité de l'actomyosine. Certains nitrites et nitrates sont utilisés pour leurs propriétés de conservation et de coloration. Les polyphosphates jouent un grand rôle dans le traitement de la viande, on les utilise en particulier pour stabiliser

1/ Les vues et opinions exprimées dans le présent document sont celles de l'auteur et ne reflètent pas nécessairement les vues du Secrétariat de l'ONUDI. Le présent document est la traduction d'un texte anglais qui n'a pas fait l'objet d'une mise au point rédactionnelle.

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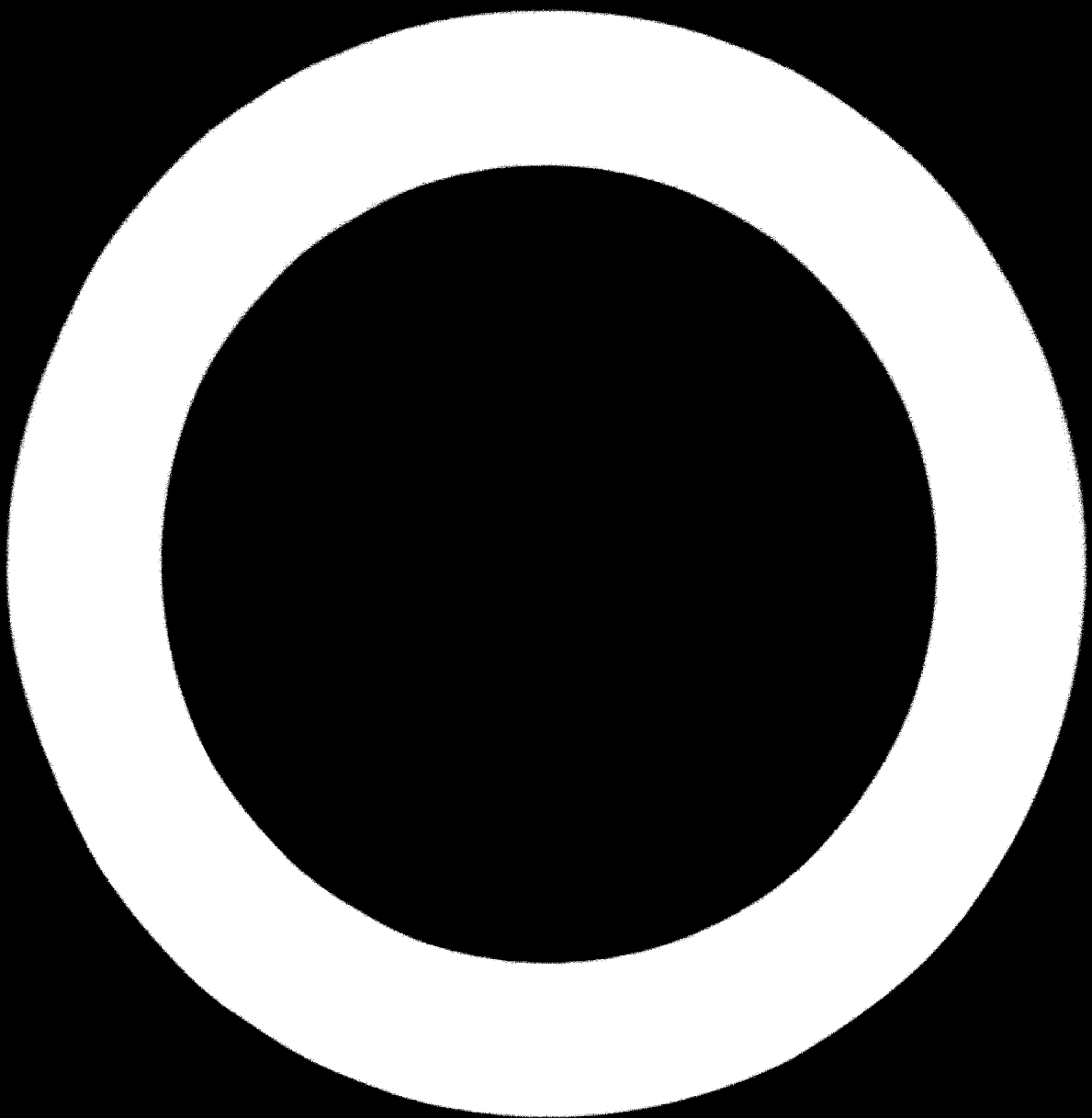

Looking back, [illegible] meat, which must be regarded as a very traditional and valuable foodstuff. [illegible] that the food of animal origin was at all times of great value, influencing the standard of living, the geographical and climatic conditions, religious rules and national eating habits.

For the human diet the most suitable preparation of meat from different animal origin is cooking, boiling, frying and roasting. For a long time this was the predominant manner of consumption. The necessity to preserve certain cuts of meat without refrigeration led to various processes, especially to curing and salting.

For a long period preservation of meat by salting was the only way to store meat, however, low temperatures were also necessary. Curiously enough a number of dry-salted meat products which formerly were produced in a very primitive way are in these days high-priced specialities of high quality (for instance Parma Ham, Lincolnshire, Prague Rollen).

Bacon being the most popular meat product in Great Britain, the United States, Canada and Australia, basically resulted from a very primitive dry salting procedure, and meanwhile had undergone fundamental changes of industrialising the curing operation up to a semi-automatical and very rapid method.

In the field of comfronted meat products in the course of centuries the development has taken very large steps which should be looked upon with great interest. The meat preparation formerly done in a household kitchen from off-cuts and by-products of a slaughtered animal has become a highly mechanized process. Heavy and very sophisticated machinery and equipment is in use for the manufacture of a great variety of products and in order to prepare these for modern presentation and distribution.

All these developments in meat manufacture were generally influenced by the increasing agglomeration of human settlements. Because of the industrialization and the development of trade and commerce in these days we are confronted with very populated areas in and around large cities and industrial districts.

The concentration of population demands the supply with sufficient and a great variety of food stuffs. So the individual small food manufacturers are to an increasing extent replaced by large manufacturing plants with large outputs.

The following dominant factors in modern meat manufacture have to be realized with regard to the necessary application of food additives

1. Re[illegible]

[illegible]

[illegible]

The application [illegible] in the preparation of meat products [illegible] salt, [illegible] for reasons of taste. The effects of Nitrate [illegible] additive [illegible] because Sodium Chloride from [illegible] sources [illegible] contain natural nitrate.

In most manufacturing [illegible] regarded as very important additives and [illegible] control.

A. The Importance of Salt, Nitrite and Nitrate on [illegible] Taste and Flavour

Processed [illegible] without salt addition are more or less neutral in taste and flavour [illegible] very unattractive. [illegible] addition of salt is more important for the [illegible] than [illegible] addition of other flavouring matters like spices or herbs. [illegible] which can fully replace salt. (1)

Sodium Nitrite ($NaNO_2$) is [illegible] as additive for all cured products. Besides its influence on colour and [illegible] it achieves a typical cured meat flavour in cooked (pasteurized, sterilized) meat products compared with the much more neutral flavour of cooked meat.

Sodium or Potassium Nitrate ($NaNO_3$ or KNO_3) are used in traditional curing processes mostly for dry-salting, pre-curing and tank curing because of the slower and longer chemical reaction in meat. It also creates a typical cured flavour, which, however, is different from the flavour achieved with Sodium Nitrite. The difference in cured flavour obtained with Nitrite respectively with Nitrate is due to the longer curing time required by Nitrate. During the first period of curing with Nitrate, no Nitrite (developed by the bacteriological reduction of Nitrate) is present and [illegible] consequently no preservative action takes place. Under these

- -

[illegible] of the meat. It is believed that in the [illegible] of meat is brought [illegible] proteolytic enzymes [illegible] and in the presence of Nitrite [illegible] Nitrite [illegible] This may be a further [illegible] Nitrite [illegible]

The practical [illegible] therefore [illegible] the use of Nitrite [illegible] is preferred.

2. [illegible] of the addition of Salt

Besides [illegible] salt [illegible] of great technical importance. It is necessary [illegible] Nitrite [illegible] the water retention capacity [illegible] of the meat. By autolysis of the meat [illegible] the presence of salt [illegible] The main factor for the solubility of meat [illegible] which originally is approx. [illegible] $\mu = \frac{1}{2} \sum c_i \cdot z_i^2$. The minimum ionic strength for solubility [illegible] Sodium Chloride [illegible] ionic strength [illegible] sufficient myosin [illegible] solution. The maximum figure of water [illegible] myosin correlating with water binding [illegible] by the addition of 5 per cent Sodium Chloride. This amount is not practical, but easily realized by so-called high-salting [illegible] for Frankfurters [illegible] the addition of water instead of a brine [illegible]

The results of [illegible] can be carried [illegible] of [illegible] for Sodium Chloride.

A further important function of Sodium Chloride is the lowering of the iso-electric point by an increase of the anionic loading of the protein. The iso-electric point represents the 0 point of the total loading and the lowest level of protein solubility. The addition of 2 per cent Sodium Chloride receives a lowering of the iso-electric point from pH 5.0/5.4 to 4.5/4.7 consequently with a longer distance to the actual pH value of the meat.

[illegible]

[illegible] not only [illegible] functional [illegible] effect on the [illegible] of the [illegible]

Sodium [illegible] effect of [illegible] tion expe-dite [illegible] Nitrite [illegible] inhibiting effect [illegible] while [illegible] Nitrate [illegible] bacteriostatic effect especially [illegible] found out that [illegible] Nitrite [illegible]

[illegible] practical experiences Sodium Nitrite [illegible] an effective preservative. It is recommended [illegible] Nitrite addition below [illegible] for controlled manufacturing standards, [illegible] the quantity of addition can be extended up to [illegible]

[illegible] Required Amounts of Nitrite and Nitrate for Curing Purposes

Theoretically the required [illegible] of Nitrite [illegible] on the amount of myoglobin [illegible] and 300 to 350 mgrs/100 grs. [illegible] to beef would be sufficient. [illegible] are required [illegible] of the different manufacturing [illegible] In most European countries there already exist regulations [illegible] of Nitrites. [illegible] only as a pre-mix with salt [illegible] per cent salt and 0.[illegible] per cent Nitrite. This practice [illegible] sure that the correct amount is [illegible] avoids failures or deliberate [illegible]

There is [illegible] for the application of Nitrate in cured/cooked products because of the short time of processing, and Nitrate has to be converted into Nitrite by bacterial reduction first. For products which are cured and matured over a longer period like dry sausages, [illegible] products, raw ham etc. the use of Nitrate is of advantage in view of a good stability of the colour. 500 to 700 ppm of Nitrate are the usual quantity of addition considering a certain depot-function for Nitrate supply during the curing, maturing and drying procedure.

Due to the fact that [illegible] is used as a supplement in cattle and poultry [illegible] and [illegible] is also available in the form of a [illegible] and [illegible] well- [illegible] enforcement.

I. [illegible]

The [illegible] of [illegible] is [illegible] of [illegible] importance. [illegible] of [illegible] and [illegible] [illegible] and universal [illegible] the application of [illegible] rule. [illegible] of Polyphosphates [illegible] [illegible] and their manufacture. [illegible] and uniformity of [illegible] Polyphosphates [illegible] very [illegible] suited for the manufacture of [illegible] products as to water holding, [illegible] and [illegible] [illegible], and retaining almost the same proportion of [illegible], [illegible]. A much more uniform raw material is obtained out of meat by different [illegible].

A. Phosphate Origin - Uses

It is a well-known fact that Phosphates are of [illegible] importance in the life of human beings, animals and plants. They are [illegible] [illegible], bones and [illegible] of [illegible] [illegible] from [illegible] and from sunlight. Phosphates are [illegible] elements of [illegible] and [illegible]. An [illegible] contents of a human being is [illegible] 1% wt. %.

Phosphate resources [illegible] [illegible] are [illegible] in North America, northern Africa [illegible] in the north of [illegible] and [illegible] other places are mineralized deposits of animal [illegible] of [illegible] origin. Phosphorus is the twelfth most abundant element in the earth's crust.

Polyphosphates are manufactured from [illegible] acids and are diversified by thermal dehydration and condensation. Polyphosphates are not toxic, the maximum consumption should be 2800 mgrs. P per head and day. The present daily consumption lies between 1200 and 1400 mgrs. P, a quantity of 1700 mgrs. per head and day is within the desirable limits.[1].

B. Mechanism of Polyphosphates in Meat Manufacture

Due to their ionic strength and complex binding capacity Phosphate salts are able to compensate for the [illegible] current of [illegible]. A dissociation of non-soluble actomyosin into the soluble actin and myosin is obtained. These are the

[illegible] water binding and emulsifying [illegible]

[illegible] polyphosphates [illegible] type and concentration of the specific [illegible] ATP.

The [illegible] is as follows:

1. The [illegible] of Spinner [illegible]
2. [illegible]
3. The [illegible] of the [illegible] of the meat closest to the optimum structure [illegible]
4. A [illegible]
5. The [illegible]
6. The [illegible] of the meat by swelling and softening of the fiber [illegible] which [illegible] the following structure:
   a) Improved [illegible] for binding, [illegible] and subsequently reconstitution
   b) Reduced [illegible] of [illegible] during [illegible]
   c) [illegible]
   d) Better "pull" in [illegible]
7. The [illegible] of the meat and the distribution of additives and spices is remarkably improved,
8. The reduction [illegible] resistance of microorganisms in the presence of Polyphosphates leads to a higher degree of pasteurization and sterilization;
9. Improvement [illegible] water-holding capacity of collagen substances;
10. Tenderization.

3. Methods of application

It is always advisable to choose a well-known manufacturer for the specified Polyphosphate types and combinations for the different applications. The criteria are pH value, viscosity, solubility, stability in the salt brine, speed of penetration and structure of the powder.

In [illegible] applications

1. Polyphosphates [illegible] for all comminuted meats and emulsions, [illegible] with Sodium Chloride and/or spices, and [illegible] for [illegible], controlled and safe handling;
2. Polyphosphates [illegible] for all kinds of cooked sausages (rings, frankfurter sausages);
3. For special [illegible] for instance soaking, injection, addition, Polyphosphates are applied as [illegible] solution. The quantity of application [illegible] %, respectively.

III. [illegible]

Emulsifiers formerly for the production of emulsion-type meat products do not play a large role in meat manufacture. The main function of phosphate-based emulsifiers is the substitution of the myosin in its function as the main emulsifier in comminuted meat products. This effect is best demonstrated in a cold-prepared emulsion.

The application of phosphate-based emulsifiers is [illegible] advantageous in cooked meat pastes like liver pâté or similar products.

IV. [illegible] VEGETABLE PROTEINS

Protein additives are needed because the available content of myosin for water binding and emulsification [illegible] sometimes meat mix is only limited.

1. The [illegible] Protein Additives [illegible] Objects and Standards

There are the following requirements for the addition of protein products:

1. Stabilization of a certain quantity of fat in the recipe which cannot be guaranteed by the quantity of myosin present in the meat;
2. The necessary structure, consistency or solidity must be achieved also with economic recipes;
3. The water retaining capacity has to be [illegible] improved;
4. In the case of canned products, stabilization of the meat mix (emulsion) during retorting in order to prevent separation and softening.

[illegible] refer [illegible] their

[illegible] with a low

[illegible] to produce a

[illegible] water : 1 part

[illegible] in the final mix for a

[illegible] when the recipe only

[illegible] be prepared. Only a

[illegible] protein, pellets can be incor-

[illegible] Beef

[illegible] should be practised only

[illegible] in the incorporation

[illegible] as well as emulsi-

[illegible] protein has

[illegible] and a low emulsification capacity. Indirectly a

[illegible] milk [illegible] that this is based on a

[illegible] be handled in

[illegible] Sodium Caseinate should be preferred

[illegible] for [illegible] luncheon Meat

and Sausages, [illegible] advantages [illegible] application in dry

[illegible] preferred [illegible] more coarse mixes

[illegible]

[illegible]

[illegible] Protein Enrichment of Meat Products

There are [illegible] reasons for protein enrichment:

1. Increase of the nutrient value;
2. Increase of the nutritional soy content according to legislation if [illegible] by the authorities;
3. Influence on the structure of the meat product by using protein meals as fillers;
4. Replacement [illegible] by textured vegetable protein (TVP)

For these purposes predominantly soya proteins or soya meals with a protein content between 20 and 60 per cent are used.

[illegible] - FILLERS - [illegible]

2. Water Retention and Free Water Absorption in Comminuted Meat Products

Under this heading the most popular additives are cereals, starches, milk powders, carrageenates and alginates. Such additives are of special importance for meat products or comminuted products where no distinct emulsification takes place. They all are moisture components and improve and stabilize for structure and texture.

Especially under practical conditions a high level of free moisture (low a_w value) in meat products is required for a number of shelf-life and consistency.

The following [illegible] definition of the field of applications:

Cereals (meals)

These products are used in comminuted products with a high meat content for improvement of the dry matter and the firmness of the product.

Starches

These substances have a high water retaining capacity and swelling effect and therefore are successfully applied in all meat emulsions especially for canning as well as for all comminuted and reconstituted meats.

Milk powder

Especially skim milk powder is used for finely chopped emulsions and liver pâtés.

Thickeners

The stabilization of creams, stocks and gravies is a wide field for the application of carrageenates and alginates.

3. Rusk in Meat Products

English Sausages, Hamburgers and Beefburgers are the main products for the application of rusk. In the sense of the incorporation of bread crumbs the application of rusk gives the meat product a loose texture without any free moisture. Rusk itself may already carry a high amount of moisture but does not create a binding effect such as for instance starch.

[illegible]

[illegible] factoring [illegible] which occurs [illegible] articles. The [illegible] complicated structured [illegible] and acting as an [illegible] sufficient [illegible] accumulation the [illegible] complex biochemical [illegible]

A. [illegible]

[illegible] of the curing [illegible]

1. [illegible] generally used ($NaNO_3$ or [illegible]) [illegible] result of the bacterial [illegible] for doing the job. [illegible] Sodium nitrate is used [illegible] of reduction and [illegible]

2. Temperature [illegible] demands low temperatures [illegible] low temperatures slow down [illegible] nitrite. [illegible] of making use of [illegible] is to apply [illegible]

3. pH [illegible] i.e. the reduction of [illegible] low pH [illegible] Normally the pH value [illegible] for the conversion of Nitrite into [illegible] turn decomposes to NO, H_2O and HNO_3 is 5.[illegible] to [illegible]

B. [illegible] Requiring [illegible] the Desired Preservation of [illegible] Products

There are three main possibilities for influencing the curing mechanism.

1. Reducing [illegible] of Ascorbic Acid results the re- [illegible] well [illegible] extended reduction of [illegible]myoglobin

independent of the given pH of the meat and in the meat mix. The quantity to be added is usually 0.05 to 0.20 %, and should be applied by incorporation to the comminuted product from a well-known supplier before the cutter process begins.

Sodium [illegible] with acetic acid is an alternative to [illegible]. These reductants react much slower than [illegible] and [illegible] the pH in the meat and in the mix. It is important that they are [illegible] - [illegible].

2. pH-Correctors: The adjustment of the pH to the optimum value for curing corresponds to the optimum value for water binding, emulsification and yield. The use of P-type products for [illegible] slow down the curing mechanism due to the slight increase of the pH value in the meat or in the meat mix.

Typical ingredients such as dry cream soup or "emulsions" like cooked sausages there is a possibility to adjust the pH in a restricted process to an optimum level in relation to the original pH value and in relation to the desired pH by different additives. The limits for the correction lie between 6.2 for "emulsions" and 6.9 for dry sausages.

The know-how of well-known manufacturers should be taken advantage of in order to select the appropriate compounds of pH-correct materials or their derivates of the lactone group (GDL) or food acids i.e. conjunction with reducing agents for obtaining a maximum cure.

Certainly it is of great importance to find out the right relation between the required pH value for yield and emulsification as well as for an improved cure/colour.

Sugars do not have a significant influence on the colour in a short cure.

Proportions of Added Nitrite and Residual Nitrite, Depending on the Curing Environment

The following tables show example the influence of curing ingredients in meat emulsions (cooked sausages):

Table 1

$NaNO_2$		Residual Nitrite %	% Reddening

Table 2

[illegible] reduction [illegible] nitrite [illegible] breakdown [illegible]

[illegible] (i.e. [illegible] product) [illegible] residual nitrite content [illegible]

[illegible] nitrite [illegible] nitrite together [illegible] with the requirements [illegible] excessive [illegible] nitrite [illegible] drastically reduced.

E. [illegible]

The following [illegible] for [illegible] conditions for [illegible] possible time:

1. A pre-[illegible] for the manufacture of cooked sausages [illegible] the [illegible] in the cutter/mixer.
2. [illegible] processed within 24 hours.
3. [illegible] buffer zone for curing purposes required. Every precautions [illegible] continuous manufacturing.
4. Smoke [illegible] full capacity because pre-curing time [illegible] and full temperature can be applied (up to 30%) saving of [illegible].

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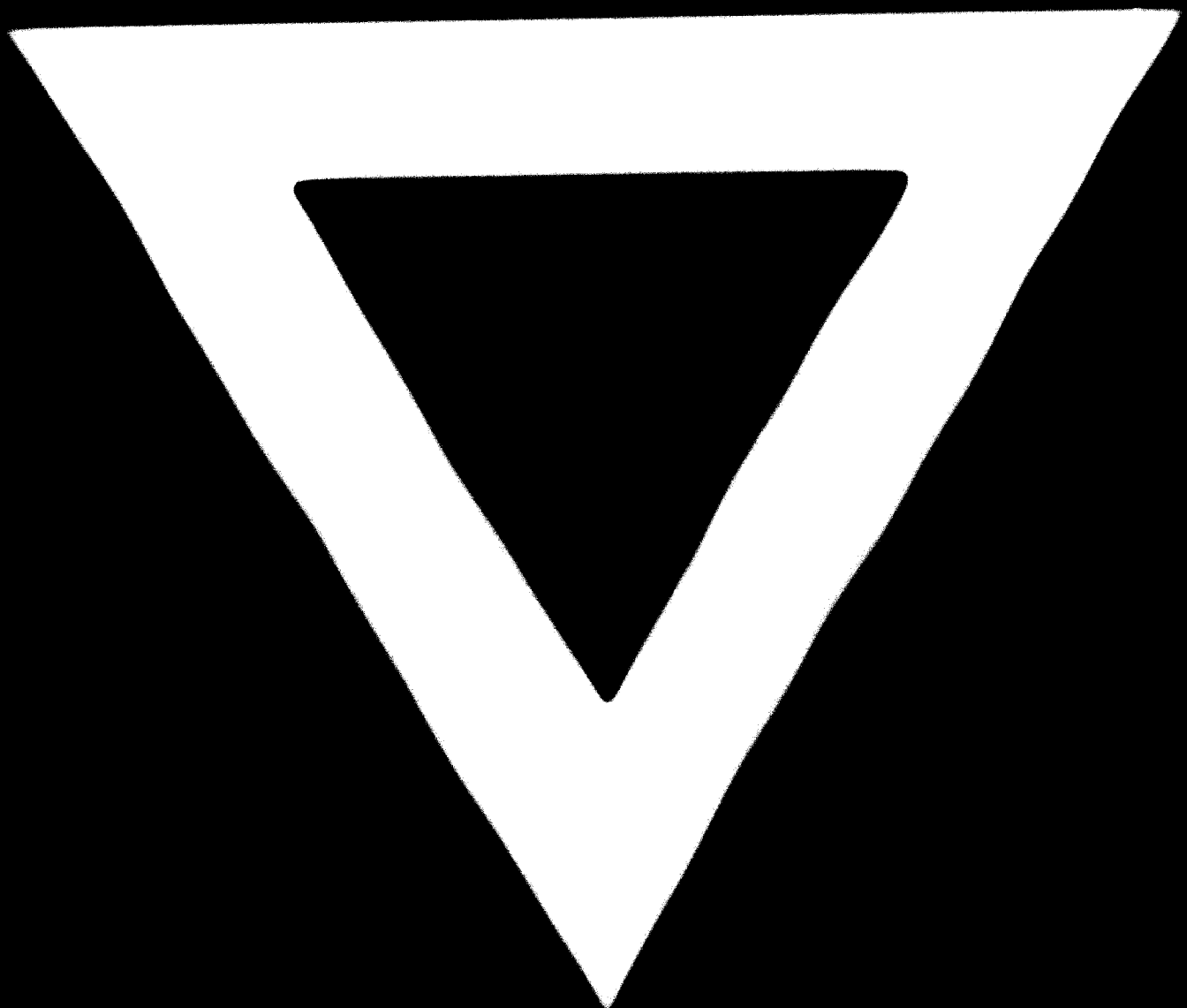

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