# Hydrolyzed Vegetable Protein as a Flavoring Agent

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Hydrolyzed vegetable protein (HVP) may be defined as a product that results from the acid, alkaline, or enzymatic hydrolysis of a proteinaceous substrate. More practically, however, it is characterized as a versatile flavoring agent that is capable of suggesting or enhancing a characteristic savory flavor.

HVP, also known as hydrolyzed plant protein (HPP), or generically as hydrolyzed protein (HP) since non-vegetable sources such as casein may be hydrolyzed, probably had a serendipitous origin in the Far East. The countries of China, Indonesia and Japan used fermentation processes for food preservation and eventually for flavor modification. It has even been speculated that microbially contaminated spices may have contributed to novel but desirable flavor development in not only fish and meat but also cereals and legumes.

At the turn of the twentieth century, in an attempt to accelerate soya sauce production, which incidentally, could take up to three years, the Japanese began to study the feasibility of chemical methods such as acid hydrolysis. In 1912, four years after Ikeda discovered the flavor significance of monosodium glutamate (MSG) in HVP, he was granted several patents describing the production of HVP. HVP then became a relatively abundant and economical source of MSG.

European HVP use began in Switzerland as a replacement for van Liebig's Extractum Carnis. This meat extract of van Liebig's suffered from supply problems and severe price fluctuations. In the late 1800s, the industrial age was bringing about some definite changes to the structure of European society. One in particular was job opportunities for women to work in factories. As a result, meal preparation time decreased, thereby affecting modifications in the family diet. Julius Maggi, a Swiss miller, was well aware of the social and economic changes, and in 1866, developed a protein-based meat flavoring to replace the Old World stockpot that simmered on every stovetop in Europe.[1]

Prior to 1935 the United States sourced HVP and MSG primarily from Japan. The impending threat of war stimulated the U.S. food industry to develop similar products. Since 1940 HVP has shown considerable growth, especially in developed countries where consumers demanded more variety and convenience in their diet and food producers required economical quality raw materials.

## Manufacture and Composition

While it is possible to produce HVP via alkaline, acid or enzymatic hydrolysis or by fermentation, this review shall be limited to acid hydrolyzed proteins. (Manley et al.[2] have reviewed alternate processes.) HVP is produced from stocks generally containing a minimum of 50% protein, but higher concentrations, 70-80% are more desirable. Common raw materials include defatted oil seeds (soy and peanut), and gluten from corn, wheat and rice. Less common substrates are potato, casein and yeast. The choice of protein source, processing aids, and process influence the flavor, physical properties, and cost of the resulting HVP.

A generalized process for the manufacture of (acid) HVP is shown in Figure 1. The reactor is charged with the protein source, water and acid. Several acids are suitable

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for hydrolysis, but the acid of choice for flavor quality is hydrochloric acid. This mixture is "cooked" at 110-130°C for up to eight hours. After cooling, the hydrolysate must be neutralized. The choice of base is, as with the acid, predicated on flavor quality. Sodium hydroxide or alternatively sodium carbonate is used. So-called "low salt" HVP may be produced by neutralizing with potassium hydroxide. The flavor quality, however, is considered inferior and is characterized by a bitter, metallic taste. The final pH is generally 5-6. Obviously the pH can affect the flavor of the HVP and the perception of the food in which it is used.

The resulting hydrolysate must be filtered to remove the humin, which is the insoluble carbohydrate degradation products. The filter may be washed and the wash liquor recovered and added to the HVP. Next, the hydrolysate must be bleached or refined. This unit process greatly influences the final flavor and color of the HVP. Activated carbon is used to remove both flavor and color to a predetermined specification. By manipulating the type and amount of carbon (generally less than 3%), the temperature and the duration of bleaching, one may produce HVPs ranging from dark brown color and strong, roasted, bitter flavor (i.e. minimal refining) to light tan color and mildly flavored (i.e. highly refined). These parameters determine the final application.

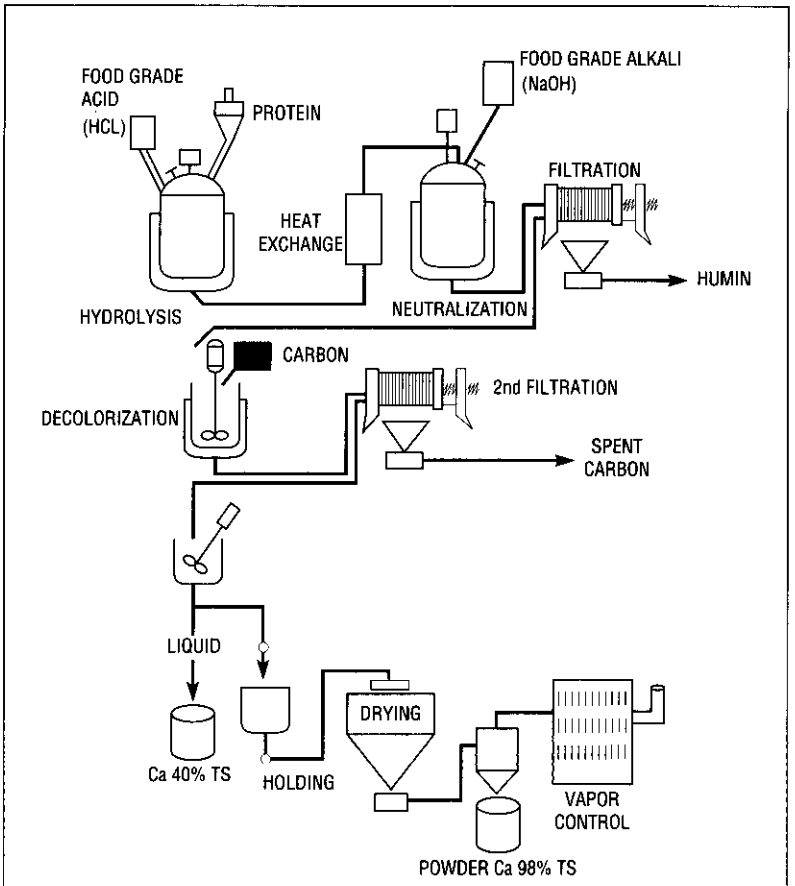


**Figure 1. HVP process**

Following another filtering to remove the carbon, the hydrolysate is pumped to a holding tank. At this stage an HVP of about 40% solid matter may be drummed and sold. Alternatively the HVP may be sophisticated by either of two methods:

- By the addition of additional flavor ingredients such as MSG, 5'-ribonucleotides, salt, spices, smoke or yeast. Caramel color is also sometimes included. These are sometimes called fortified or flavored HVPs.
- By the addition of flavor precursors such as reducing sugars, amino acids (usually cysteine), micronutrients (usually thiamine), and in some instances lipids. This mixture is then heated to develop more characteristic and intense meat flavor. Recall that compared to meat, HVP is deficient in sulfur amino acids, vitamins and lipid. These may be referred to as processed HVPs or processed flavorings.

The liquid may be concentrated, usually by spray drying. Due to the hygroscopic nature of spray dried HVP, some suppliers coat it with a partially hydrogenated vegetable oil. The compositions of typical HVPs prepared from wheat, corn and soy are displayed in Table I. The amino acid profiles of typical HVPs are in Figure 2.

**Table I. Composition of HVP (% by weight)**

| | Wheat | Soy | Corn |
|---|---|---|---|
| Water | 2.0 - 4.0 | 2.0 - 4.0 | 2.0 - 4.0 |
| Sodium Chloride | 39.0 - 44.0 | 42.0 - 45.0 | 42.0 - 45.0 |
| Fat | 0.2 - 2.0 | 0.2 - 2.0 | 0.2 - 2.0 |
| alpha-Amino Acids | 43.0 - 52.0 | 26.0 - 52.0 | 26.0 - 40.0 |
| Carbohydrates | 0.1 - 0.2 | 0.5 - 0.7 | 0.1 - 2.0 |
| Organic Acids* | 6.0 - 7.0 | 8.0 - 9.0 | 8.0 - 9.0 |
| Ammonium Chloride | 4.0 - 6.0 | 1.0 - 3.0 | 1.0 - 3.0 |
| Aroma Volatiles | < 0.01 | < 0.01 | < 0.01 |
| pH | 5.0 - 5.5 | 5.0 - 5.5 | 5.0 - 5.5 |

* The major organic acid is levulinic acid. Other acids present are lactic, succinic, acetic, formic, and pyrroglutamic.

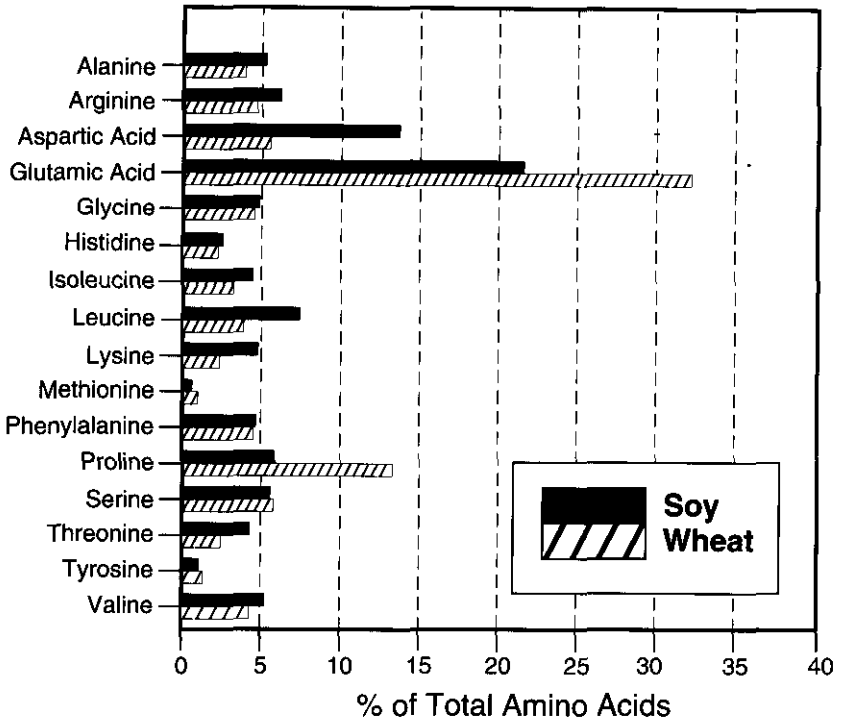


**Figure 2. Amino acid profile of HVP**

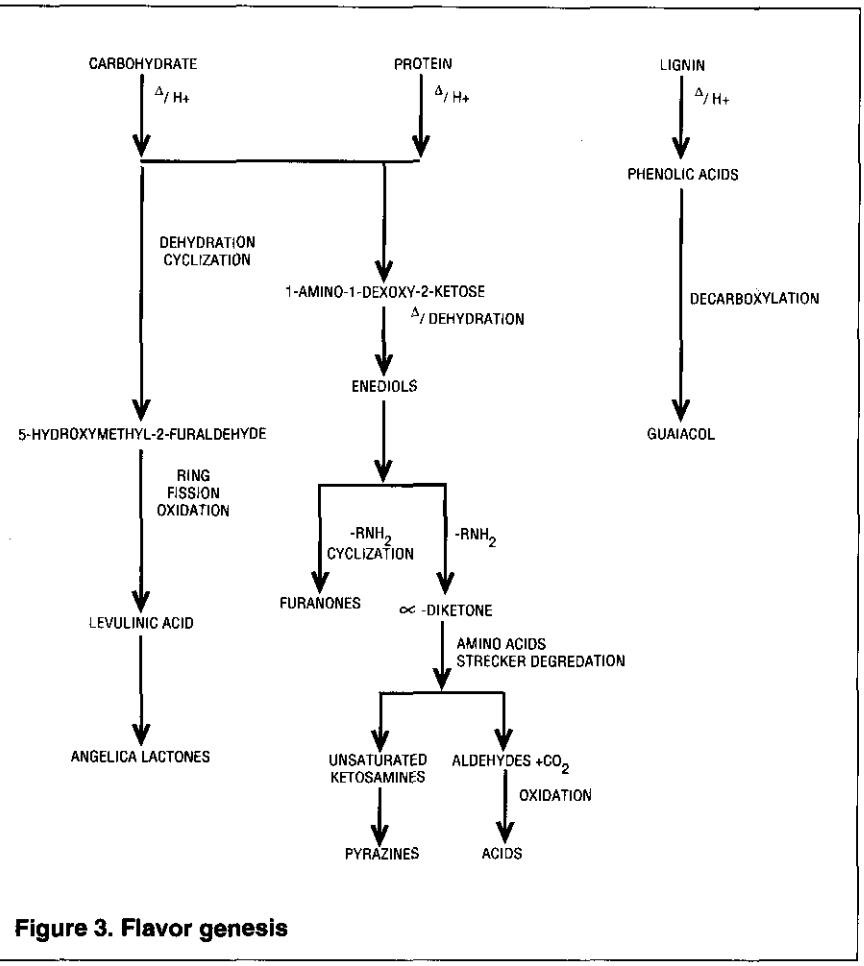


**Figure 3. Flavor genesis**

## Flavor Chemistry

Flavor chemicals in HVP may be divided into two categories, non-volatile and volatile. Non-volatile compounds are considered to be predominantly flavor enhancers. MSG, which may be present in concentrations as high as 20%, has been well documented as a significant flavor enhancer in meat and savory foods.[3] MSG intensifies and enhances the inherent flavor of foods. It is responsible for the Umami effect that is characterized by a mouthfillingness. To a much lesser extent aspartic acid exhibits this effect. Salt, present at about 40%, suggests its characteristic flavor to foods. At carefully controlled concentrations, however, salt may enhance or mask food tastes and flavors. Bitterness and sourness may also be controlled by the degree of carbon treatment (refining) and neutralization, respectively.

The thermal processing required in the manufacture of HVP induces chemical transformation of carbohydrates, proteins, amino acids and lignin. Just as with post mortem changes and cooking of meat, water soluble, dializable precursors generate potent savory flavor compounds.[4,5,7] The major mechanism for the formation of these compounds is the amino mediated degradation of reducing sugars. Lignin degradation has also been implicated in HVP flavor. These mechanisms are detailed completely by several researchers.[2,6-8] This chemistry is summarized in Figure 3.

Table II shows a compilation of significant volatile flavor compounds and their contribution to HVP flavor.

## Applications

Manley and Swaine[9] have used the following nomenclature to describe HVP applications.

***Enhancer:*** These are usually prepared from corn or wheat and have been highly refined (bleached) with activated carbon to remove the majority of the color and aroma. The high concentration of MSG provides excellent flavor enhancing or intensifying properties. Enhancers find application in soups and snack

**Table II. Key volatiles in HVP**

| Chemical | Flavor Properties |
|---|---|
| **Aldehydes** | |
| 5-Methylfurfural | sweet, caramel, spicy |
| Benzaldehyde | bitter almond |
| Ethanal | sharp, pungent |
| Furfural | sweet, caramel, nutty, almond |
| Phenylacetaldhyde | sweet, floral, honey |
| **Ketones** | |
| 2-Furyl methyl ketone | sweet, caramel, musty, almond |
| Acetophenone | phenolic, almond |
| 2-Butanone | ethereal, burnt |
| **Organic Acids** | |
| Formic | pungent |
| Acetic | vinegar, sour |
| Butanoic | fatty, rancid butter |
| Valeric | fatty, cheesy |
| Isovaleric | sharp, cheesy |
| 2-Methylbutanoic | cheesy, sour, fruity |
| 2-Furanoic | burnt sugar, sour |
| Phenylacetic | honey, malty |
| **Furans** | |
| Furan | ethereal, burnt |
| 4-Hydroxy-2-ethyl-5-methyl-3-(2H)-furanone | sugary, sweet, fruity |
| 3-Hydroxy-5-ethyl-2-methyl-3-(2H)-furanone | caramel, Maggi |
| **Pyrazines** | |
| 2,5-Dimethyl | potato, roasted, nutty |
| 2,3-Dimethyl | nutty, coffee, cocoa, green |
| 2,6-Dimethyl | roasted, cocoa |
| 2-Methyl | musty, nutty |
| 2,3,4-Trimethyl | roasted, caramel, cocoa |
| Tetramethyl | roasted, fermented soy |
| 2-Ethyl-3,6-dimethyl | roasted, earthy |
| **Phenols** | |
| 2-Methoxy | burnt, phenolic |
| 4-Ethyl | smoky, medicinal, woody |
| 4-Methyl | phenolic, cresol |
| 3-Methyl | phenolic |
| **Miscellaneous** | |
| Maltol | caramel, sweet |

foods, and are very useful in chicken, pork and provide fish flavorings.

***Full-Bodied:*** HVPs in this category possess sweet, savory, meaty aroma (if moderately refined), or potent, roasted, even charred aroma (if only slightly refined). The former finds general use in both chicken and beef formulations while the latter is restricted to strong beef and onion-type flavorings.

***Sophisticated:*** As mentioned earlier when discussing manufacture, sophisticated HVPs contain additional colors or flavorings and are used for their higher fidelity. The flavor profile of an HVP may be altered or fortified with spices or MSG, for example, to deliver a proprietary flavoring or seasoning. The supplementation of a basic HVP with the appropriate (sulfur) amino acid, reducing agent, lipid, and vitamin and the subsequent thermal processing results in more intense species-specific meat flavor.[10] This type of HVP is referred to as a processed HVP or a processed flavoring.

The typical ranges for the use of HVP are:

| | |
|---|---|
| analogs | 1.0-2.0% |
| bouillons | 0.2-0.5% |
| gravies and sauces | 0.5-1.5% |
| reformed meats | 1.0-2.0% |
| snacks | 0.5-2.5% |
| soups | 0.1-1.0% |

## Regulatory Status

As so often is the case in the food and flavor business, the regulatory status of HVP is not as straightforward as the title of this review would imply. Although the creative flavorist may consider HVPs to be natural flavorings, and traditionally could label them as such in foods, recent legislation has changed the manner in which we must treat HVP with respect to labeling. This has been necessitated by the Nutritional Labeling Regulation and the growing consumer awareness of food allergies and idiosyncratic reactions to food ingredients, monosodium glutamate, and soy or wheat proteins, for example.

It is not the intent of this review to take the place of inhouse regulatory departments who can best guide the flavorist and the food product developer. A brief overview of the basics may, however, be helpful. HVPs may no longer be labeled as flavoring or natural flavoring. Bulk labels must declare HVPs. HVPs must state parenthetically that they contain glutamate. It may even be necessary to indicate the source of hydrolyzed protein.

### References

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