spontaneous change into carbonic acid and alcohol, though when once begun, the process will probably go on without further assistance.

Some of the most common fermenting ingredients as the sweet infusion of malt, technically called wort, it is well known will slowly enter into fermentation without the addition of yeast: Hence chemists have sought in this substance for the principle which gives the first impulse to the fermentation of sugar.

Lavoisier remarked, that, the matter of yeast is a compound of carbon, hydrogen, oxygen and nitrogen, and is therefore so far of an animal nature. From the more recent researches of Fabroni, Thenard and Seguin, it is proved, that it is a substance analogous to gluten or albumen which exists in yeast, which is derived from those vegetable juices or infusions that without any addition are capable of fermenting, and which excites the vinous fermentation.

Fabroni, as the result of his researches on fermentation announced, that though saccharine matter is the principle necessary to vinous fermentation, it does not ferment alone, but only by the aid of another substance capable of acting upon it; this substance is the glutinous or vegeto-animal matter, which exists in the nutritive grains, and which, as he stated, is also contained in the grape, being deposited from its juice. When the deposition is complete, or rather when the glutinous matter is perfectly separated by repeated fil-
trations, the juice does not ferment, but the sediment, mixed with a substance susceptible of fermentation causes it to pass into that state.

It is this vegeto-animal matter, according to Fabroni, which principally constitutes the yeast of wine or beer: and Rouelle long ago found, that the sediment deposited from wines in fermentation is of this nature, as it affords much ammonia when decomposed.

Mons. Thenard of Paris, found that this substance was deposited from the juice of the grape, the cherry, apple, pear, and other fruits, during their fermentation; and those which afforded the largest quantity of it, were those which run most quickly into the vinous fermentation. It is always deposited too, as their fermentation proceeds; and a sediment of yeast always appears, when alcohol is formed.

When dried, it is still capable of exciting fermentation, and may be preserved in this state for an indefinite time.

These researches however still leave a degree of obscurity with regard to this principle; whatever may be its nature, it must exist in the sweet vegetable juices, and in the infusions of the grains that have been subjected to malting, since these are capable of passing into the vinous fermentation without the addition of yeast, and even deposit it as the process proceeds.
It has been generally supposed, that no substance enters into the vinous fermentation, except sugar, or from which sugar may be extracted; and that the process of malting grain was necessary to develop the sugar or saccharine matter to render it susceptible of vinous fermentation. The practice however of grain distillers proves this to be a mistake, as they obtain as much spirit from a mixture of malted with unmalted grain, as if the whole were malted.

That fecula alone, or at least mixed with no more saccharine matter than what is contained in the grain, may be made to ferment, is established by the experiments of Fourcroy and Vauquelin.

Twenty-four pounds of the flour of the unmalted barley, having been put into a vat with seven times its weight of warm water, and four pounds of yeast, entered into a strong fermentation, which continued several days. The liquor at the end of that time, submitted to distillation gave a weak spirit, which by rectification afforded alcohol. The quantity amounted to twenty-three ounces.

Now Lavoisier had established, that 100 parts of sugar give fifty-eight of alcohol; and as twenty-four pounds of unmalted barley contained only five ounces of sugar, it follows that four times more alcohol had been formed than that sugar could have furnished; a large quantity of it had therefore been formed from the fecula of the grain.
Vinous Fermentation.

It is suggested, that even in this process, the secula may proceed rapidly through the intermediate state of sugar, in passing into the vinous fermentation;* from the circumstance, that when the flour of unmalted grain is mixed with a quantity that has been malted, the whole, mixed with water, becomes sweet. This however, only proves, that the flavour of the sugar is stronger than that of the secula.

Our knowledge of the series of chemical changes which constitute vinous fermentation, is still imperfect. The facts are not yet sufficiently ascertained to admit of any certain conclusions being drawn, much less of a perfect theory being delivered, since amid the theory which still prevails, various suppositions, a priori, perhaps equally probable, might be formed as to the reciprocal actions of substances, the elements of which are so much disposed to mutual combinations, as those concerned in fermentation; and the subject must still remain to be elucidated by further research.

The properties of the fermented liquor, its odour, pungency, and intoxicating quality are owing to the presence of a substance which can be separated from

* There can be no doubt of this fact in the mind of any one who has attended to the process of mashing in our grain distilleries. By the high heat at which the unmalted grain is kept for some time, the same change into saccharine matter takes place as is produced by the process of mashing. This is evidenced by the taste, which is perfectly sweet, if the proper degree of heat has been observed; but otherwise, little or no sweetness is perceptible. And the produce in spirit is always in proportion to the sweetness of the mash or wort previous to fermentation.
it by distillation, and which, in a pure state, possesses these qualities in a much higher degree. It constitutes in the state of dilution in which it is obtained by distillation, vinous spirit, or, as obtained from the different fermented liquors, from which it derives peculiarities of taste and flavour, the spirituous liquors of commerce. These, by certain processes, afford this principle pure, and the same from all of them: in this pure state, it is called spirits of wine or alcohol.
CHAPTER XVIII.

Of Hops.

GOOD hops have a lively fragrant smell, and when rubbed between the fingers, leave a disagreeable clamminess not unlike that occasioned by brown sugar.

They are employed to regulate, not promote vinous fermentation; a pure malt-wort would complete its vinous fermentation upon the first experience of warm weather, and pass rapidly into vinegar.

The common country hops are seldom well saved; those from New England should be preferred whenever they can be obtained.

The time of picking, the mode of curing, the care in bagging, and the place of keeping, all have their share in the preservation or destruction of the finer qualities of this vegetable. If the hop be plucked too early, the consequence of immaturity is obvious; if it hang too late, the constant evoluation of its fine unctuous parts, wastes its fragrance, destroys its colour, and renders it of less value and efficacy. An application of too much heat in the curing has similar effects, for by evaporating the aqueous parts of the vegetable too hastily, the finer parts of the essential oil rise with
them, and are lost, whilst the remainder receives an injury somewhat similar to that of malt by the like injudicious treatment.

The care in bagging and keeping is equally important, on the same principle of excluding, as much as possible, the action of the external air upon the hop, which carries off its more valuable qualities in the same manner as by a too long continuance on the plant. The closer they are pressed down in the bag, the more effectual is their security against this injury, and the best method of keeping them is in a close but dry room, the bags laid upon each other, and the interstices well filled with a dry inodorous matter, such as the first screenings of malt, &c.

Several qualities reside together in the hop, which however, may be separated, and the aromatic flavour, and grateful, mild, astringent bitter, may be extracted alone, without the austere nauseous one, which is produced by long boiling.

For experience has proved, that the aromatic flavour of the hop was extracted by the gentle heat of infusion in hot water, that upon a quarter of an hour's boiling, the pleasant bitterness, and the agreeable part of the astringency, came next, and when the boiling was continued about an hour, the nauseous, austere, acrimonious roughness became perceptible, and shewed itself more and more, as the boiling continued, while the aromatic, grateful parts, after boiling an hour, be-
gan to be volatilized, and were soon after evaporated and lost, till at length, nothing but a mere bitter, like that of quassia, but much more nauseous, was all that was left.

A patent has been granted in England to Henry Tickell, for a mode of preserving the essential oil of hops. A particular description of the machinery may be found in the Repertory of Arts. I do not consider it worth transcribing.

[The following publication from a very respectable gentleman in one of the eastern states, contains so much important information respecting the culture of the Hop, that I will be readily excused for its insertion.]

"The intrinsick value and extensive use of the humulus lupulus or hop, is so universally known, and all its excellent qualities converted to their full account with so much simplicity and ease, that it excites our surprise to see the cultivation of this inestimable vine so little understood, or so much neglected, especially in those sections of the country where it is most used, commanding the highest price, and in a soil where it would flourish to the highest decree of productiveness. In New England, particularly in the state of Massachusetts, where the hop is cultivated with great success, on an extensive scale, the soil is far inferior to those of the western or middle states; yet in one county, (Middlesex,) and a few towns of another, (Essex,) there are undoubtedly more hops raised than in any
Of Hope.

other five states, or even perhaps the whole union. The vine is cultivated with much more labour and expense, and yet the produce sells at a price less than in those states where it is most used, and might be cultivated on the most advantageous scale, not only as an article of domestick utility, but a staple commodity for exportation."

"The hop is of the reptile species, and is sexified; the female flower being far superior to the male, both in size, weight and quality. Its culture is simple and easy when well understood, and will render a profit, even in Massachusetts, at 12½ cents per pound."

"The ground selected for a hop field should be a dry rich meadow or river flat, as far from the stream as may be, but never ascending a step. If the field has been under a growth or crop, it should be well ploughed in the month of October, and the roots placed the distance of four feet apart: four roots, in parts containing one or more joints, placed in each hill at a convenient distance from each other, and the whole covered with earth or manure. In April, or as soon as the frosts have subsided, the mounds are to be carefully opened, as the young shoot is very tender. The vine will then be suffered to grow, the plough having passed at right angles across the field, until the vine shall have acquired a sufficient length and strength to ascend the poles. Poles must then be set, two or three in a hill, according to the appearance of the
vines.” The best vines are then very carefully wound spirally up the poles, with the course of the sun; no more than three healthy vines to a pole; the residue are suffered to languish; those which ascend being secured by a thread, generally in two or more places, as the poles are of length, say from 12 to 20 feet.

“...The hop field is generally ploughed, and hoed from three to four times, first at the time of poleing, and last when the flower bells, which will be in August, either earlier or later, according to the season and climate. It ripens in all September, and which is known by the seed, which changes its orange colour to a brown smoke; it is then gathered with the utmost expedition, as the equinoctial storms destroy the flower when they occur at this state of the ripened top.”
CHAPTER XIX.

To make four Gallons from the Bushel:

(From M’Harry’s Distiller.)

"THIS is a method of mashing that I must approve of, and recommend to all whiskey distillers to try it; it is easy in process, and is very little more trouble than the common method, and may be done in every way of mashing, as well with corn as rye, or a mixture of each, for eight months in the year; and for the other four, is worth the trouble of following. I do not mean to say that the quantity of four gallons can be had at an average, in every distillery, with every sort of grain, and water, and during every vicissitude of weather, and by every distiller; but this far I will venture to say, that a still house that is kept in good order, with good water, grain well chopped, good malt, hops, and above all, good yeast; together with an apt, careful, and industrious distiller, cannot fail to produce at an average for eight months in the year, three and three quarter gallons from the bushel, at a moderate calculation. I have known it sometimes to produce four and an half gallons to the bushel, for two or three days, and sometimes for as many weeks, when perhaps, the third or fourth day, or week, it would scarcely yield three gallons; a change we must ac-
Four Gallons from the Bushel.

count for, in a change of weather, the water, or the neglect or ignorance of the distiller. For instance, we know that four gallons of whiskey is in a bushel of rye or corn, certain, that this quantity has been made from the bushel; then why not always? Because, is the answer, there is something wrong, sour yeast, or hogsheads, neglect of duty in the distiller, change of grain or change of weather, then of course, it is the duty of the distiller to guard against all these causes as near as he can. The following method, if it does not produce in every distillery the quantity above mentioned, will certainly produce more whiskey from the bushel, than any other mode I have ever known pursued.

Mash your grain in the method that you find will yield you most whiskey; the day before you intend mashing, have a clean hogshead set in a convenient part of the distillery; when your singling still is run off, take the head off and fill her up with clean water, let her stand half an hour, to let the thick part settle to the bottom, which it will do when settled; dip out with a gallon or pail and fill the clean hogshead half full, let the hogshead stand until it cool a little, so that when you fill it up with cool water, it will be about milk warm; then yeast it off with the yeast* for making four gallons to the bushel, then cover it close, and let it work or ferment until the day following, when you are going to cool off; when the cold water is running

* No directions are given for making this yeast.
into your hogshead of mashed stuff, take the third of this hogshead to every hogshead, (the above being calculated for three hogsheads,) to be mashed every day, stirring the hogsheads well before you yeast them off.

Remarks by H. H.

The foregoing is published, because the writer says he has practised it with success; I must however, differ with him as to "ease" with which this plan may be adopted. With a patent still it is wholly impracticable, and with the other stills, it certainly is a very troublesome piece of business to empty a still with a gallon measure. The time taken up to do this, added to the time necessary for the still to cool, will be so great, that only two instead of three charges can be run a day.

Somewhat similar to the above, is the following plan. It is however much easier, and I think will be found equally profitable:—Have a small cistern placed over the swill cisterns, so high as to be over the tops of the mashing hogsheads in the house; when the swill becomes cool, pump up with a small pump, to be provided for the purpose, about one hundred and fifty gallons of the top or thinnest of the swill into the upper cistern, of this put twenty or twenty-five gallons into each hogshead at cooling off; this is called the returns.
CHAPTER XX.

Process by which eight hundred to eight hundred and twenty pounds of corn, yield four hundred thirty-two to four hundred forty-eight quarts of the best brandy.

Take 800 to 820 pounds of corn good weight, and make it sprout; for this purpose either pure wheat or rye may be employed, or add one-third of malted barley, and mix them before they are ground.

To form the first paste after the corn is ground, the water should not be hotter than 30° Reaumur, or 100° Farenheit. If that liquid contain carbonic acid it should be heated to ebullition, and afterwards suffered to cool to the degree specified. When the water contains none of that acid, mix three parts of that liquid, when boiling, with one part of cold water, and let it stand to cool a few moments. Take three parts of this water to two parts of ground corn, according to a measure corresponding to the weight, and mix the water well with the corn, to form an equal paste free from lumps. In this manner the first distillation is begun in autumn; for the succeeding ones, the water remaining from the first distillation is used, after being left to cool to 38°, and then the paste is made with it. This water augments the quantity of brandy produced.
Distillation of Corn.

For diluting employ boiling water; pour it slowly upon the paste, continuing to beat it up; add five parts of water to one of paste, which makes the mixture consist of eight parts of that liquid and two parts of corn. Then cover the tub or vat containing the matter, and leave it covered for two hours. At the expiration of that time, uncover it for four hours, for the purpose of reducing the heat, and the cooling may be promoted by stirring the matter every few minutes.

After this add ten parts more of cold water, and beat up the whole with care. This addition will give the preparation the necessary degree of dilution, and will reduce it to a temperature that cannot exceed 17½°, nor be under 16° of Reaumur. Instead of water, as much clear liquor as the operator has at his disposal may be employed. For this purpose draw off, after every first distillation, all the liquor above the pulp, and let it cool in large tubs. This clear liquor considerably augments the quantity of brandy that is obtained.

Then add 60 lbs. yeast to 800 lbs. of corn. To prevent the sour portion which remains in the vat, and which it is impossible to take out, from turning the whole mixture sour, and to disengage a certain quantity of carbonic acid, add 1¼ ounce of good potash, or a pound of good wood ashes sifted, and well beat up the matter.

The vat must then be covered for eighteen hours;
after which half uncover it, and when the temperature increases uncover it entirely after six hours more; if attention were not paid to this particular, a great part of the spirit would be volatilized. If a white froth appear upon the surface it is a sign that the fermentation proceeds as it ought.

Forty-eight hours after the mixture of the paste, the pulp begins to rise; this disposition is promoted by gently stirring the matter, and covering the vat a second time. In seventy-two to ninety hours the whole becomes clear and the fermentation is finished.

The vats must not be larger than to supply one, or at most two distillations. The distilled liquor is rectified every day to half proof, and only to whole proof when there is sufficient to fill the still.

For distilling in summer take a sixth part less of corn to the quantity of water prescribed; and after the addition of the cold water, the degree of temperature should not exceed 8° or 9° of Reaumur.
CHAPTER XXI.

Process of Distillation in Ireland.

The following account of the process of distillation is taken from the deposition of James Forbes, esq. of Dublin, for many years concerned in a large distillery. It is extracted from the report of a committee appointed for certain purposes by the House of Commons, and published by their order.

As it gives a complete view of the process of the distillery in Ireland, so very different from ours, I have been induced to insert it.

"The corn is first ground, then mashed with water, and the worts, after being cooled are set for fermentation, to promote which, a quantity of barn is added to them, and they become wash; the wash is then passed through the still, and makes singlings, and they being again passed through the still, produce spirits; the latter part of this running being weak, is called feints; when the singlings are put into the still a small quantity of soap is added, to prevent the still from running foul; a desert-spoon full of vitriol, well mixed with oil, is put into a puncheon of spirits, to make them shew a bead when reduced with water; this is only done with spirits intended for home consumption, and
no vitriol is used in any other part of the process. In this distillery the former practice was to use about one-fourth part of malt, and the remainder a mixture of ground oats, and barley and oat-meal; latterly the custom has been to use only as much as would prevent the kieve, (near vat,) from setting. He had found that malt alone produced a greater quantity of spirits than the mixture of malt and raw corn, of the same quality with that of which the malt had been made. He generally put from fifty to fifty-four gallons of water to every barrel of corn, of twelve stone, (14 lbs. to the stone). Each brewing was divided into three mashings, nearly equal; the produce of the two first was put into the fermenting backs, and the produce of the last, which was small worts, was put into the copper for the purpose of being heated, and used as water to the next day's brewing, when as much water was added, as would make, with the small worts of that brewing, 54 gallons to each barrel of corn. The kieves were so tabulated that he always knew the quantity of worts that would come off at each mashing. Their strength he ascertained by Saund-der's saccharometer, and at the above proportions he obtained from a mixture of the two first worts, an increase of gravity from 20 to 22 pounds per barrel, of 36 gallons, above water proof, at a temperature of about 88. The small worts gained at the same temperature, about six pounds. The grain, after the last worts were taken off, retained nearly the same bulk as when put into the kieve; the whole of the grain was put in at the first mashing, he never knew any grain to be
added to the second mashing. The worts of the first and second mashings were run through the mash kieve into the underback, in which state they were usually found to correspond with the computation made in the mash kieve and underback, in the latter of which a correct guage might be taken of them. He usually commenced brewing about six o'clock in the morning; the first worts were run off into the underbacks, and required from an hour to an hour and a half to be forced up into the cooler. The second worts came off at the end of two hours from the discharge of the first, and required about the same time to pass into the coolers. The small worts were generally run off late at night, and being then, or early on the following morning, put into the copper to be used for the next brewing, were seldom shewn on the coolers. He thinks that any decrease of the worts by evaporation, whilst on the coolers, must have been very inconsiderable, and that a correct guage of the worts might be taken as well in the coolers as in the underbacks. The quantity of wash in the backs was found to be nearly correspondent with that of the strong waters which had been on the kieve and in the cooler. The fermentation of the worts was produced by means of yeast, and was in general so contrived as to be apparently kept up for the full time allowed by law, (six days;) he has, however, usually had his worts ready for the still in twenty-four hours from the time in which it was set. Backs are renewed in two ways, either by additions made to them from other backs in the distillery, each supplying a certain portion of wash
to the back which is next before it in the order of fermentation, while the newest and least fermented wash is replenished by worts, or when the fermentation is down, by an entire substitution of worts. He has ordinarily in course of work, charged a 500 gallon still with wash, and run it off in from 20 to 25 minutes. He has seen a 1000 gallon still charged and worked off in twenty-eight or thirty minutes. He understands that it is now the practice of some distillers to heat the wash nearly to the state of boiling, before the still is charged with it, by which means he believes the process to be accelerated by three or four minutes. He has seen a 1000 gallon still charged with singlings, and worked off in from forty to fifty minutes, and thinks a 500 gallon still requires nearly the same time. Feints from pot-ale, (the name given to completely fermented wort,) usually are run off in from six to seven minutes, making allowance for every delay; about six charges of spirit may be run off from a still of 500 gallons content, each charge estimated at 150 gallons. The feints were always put back into the pot-ale receiver; 20 gallons of feints is the usual quantity run from a 500 gallon still charged with singlings; he thinks there is more spirits extracted from feints than from pot-ale. There was no delay between one charge of pot-ale and another, or between one of singlings and another, the still could be cleansed in less than a minute; it very rarely occurred that the ordinary accidents which happened to the still delayed the work to any considerable degree. The still is never charged with wash beyond about seven-eighths of the still, nor
with singlings beyond about four-fifths, exclusive of the head. The estimated produce, (according to which the duty may be charged,) is one gallon of singlings from three gallons of wash, and one gallon spirits from three gallons of singlings, but it is frequently somewhat more. Previous to the regulation [the excise] which took place in June 1806, from a still of 540 gallons, which is charged with 2075 gallons of spirits weekly, he has frequently drawn 5300 gallons in one week, and thinks 5000 to be a fair average.
CHAPTER XXII.

Of Lutes.

It would seem almost unnecessary to make any observations on the necessity of a proper kind of luting, or paste to prevent the loss of liquor, by flying off in the form of steam. This however is a part of the operation which requires close attention.

It is too common with distillers, in many parts of the country to make use of any kind of clay or loam that may be found about the distillery, giving as a reason that it is too expensive to use rye meal; thus they frequently lose as much in one day as would supply a proper lute for twelve months. For, so soon as the clay becomes hardened, it cracks in a hundred places, and the steam pours out at every opening.

For all the operations of a grain distillery, both singling and doubling, paste made of rye meal and water, well worked in the hand, will be found not only to be the best, but the most economical that can be used; but for the nicer operations of a cordial distillery, or in the making of spirits of wine, where the subject disengaged is of a very volatile nature, a stronger luting
than the above will be found necessary. The cheapest and most simple of this kind, may be made by a mixture of quicklime with the whites of eggs, worked to a proper consistency: this must be used as soon as made, as it dries almost immediately.
CHAPTER XXIII.

Observations on the advantage of preparing Whiskey for market, of a proper strength; and of the mode of inspecting Whiskey.

Of the numerous plans adopted by distillers to increase their produce, there is none so improper in itself, so deceptive to the purchaser, or eventually injurious to the distiller himself, in any situation, as that of putting a false bead upon gin and whiskey.

To correct this evil, to place the ignorant purchaser upon a footing with a more skilful one, and to do justice to the distiller who sends his spirit to market of a proper strength, the corporation of the city of Baltimore in the year 1807, passed an ordinance subjecting to inspection, all gin and whiskey which might be offered for sale in that city. Similar ordinances are now in force in New-York and Philadelphia.

Notwithstanding this regulation, many distillers continued to send their whiskey to market considerably below proof, under a belief that it was the most advantageous plan. To correct this mistaken notion a calculation is subjoined of the expenses and net proceeds upon the quantity made in one year, if sent to market of a proper strength; also a calculation of the same of reduced ten degrees below proof.