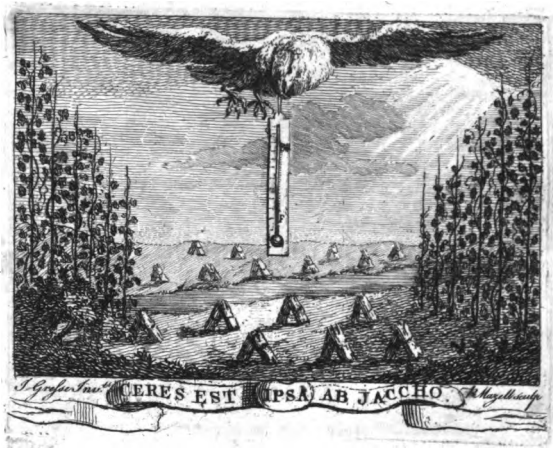
AN ESSAY ON BREWING.

WITH

A View of eſtabliſhing the Principles of the ART.



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MDCCLVIII.

TO THE

Maſter, Wardens, and Members of the Worſhipful Company of BREWERS in *London.*

GENTLEMEN,

A Long and continued attention to every event, that happened in the courſe of many years brewing, and an inquiry into the reaſons thereof, is the foundation of this Theory of the Art, if ſo it may properly be called.

A ſincere deſire to ſerve the community, by eſtabliſhing the Art of Brewing on invariable principles, inſtead of uncertain practice, was my motive for writing the following

ſheets. I would not, however, have preſumed to lay them before the public, and put them under your patronage, had they not received the approbation contained in the following letter; which does me ſo much honour, and will do the Public ſo much ſervice, by engaging their attention to what comes recommended by ſo great a name. I am,

GENTLEMEN,

Your moſt obedient, and

moſt humble Servant,

Hampſtead,
1758.

M. COMBRUNE.

[I have the Doctor's Leave for publishing the following Letter, which he was so obliging as to write to me, after perusing this little Essay.]

DEAR SIR,

I Have, with pleasure and improvement, read over your Manuscript; and should be glad to see some other Trades as justly reduced to Rule, as you have done that of Brewing: *which would not only be making a right application of philosophical knowledge; but, at the same time, accommodate human life, in many respects, wherein it is still deficient. Perhaps your example may excite some other able men, to give us their respective trades, in the form of so many Arts. For my own part, having long wished to see some attempts of this kind, for the*

good of Society in general, I cannot but be particularly pleaſed with the nature, deſign, and execution of your Eſſay; and am,

DEAR SIR,

Your obliged Friend,

and humble Servant,

Pall-Mall, July 20. 1758.

PETER SHAW.

IN-

INTRODUCTION.

AN inquiry into the antiquity of the art of Brewing would certainly be a curious, but, I fear, a very uſeleſs reſearch. In all probability, the inhabitants of the northern countries, ſoon after they ſettled there, found out a method of obtaining a liquor from Grain, ſimilar to Wine; and, indeed, the mention of Beers, or Barley Wines, by ſome hiſtorians, who

who treat of the colder parts of the Globe, where the Grape will not ripen, ſeems to put this matter beyond doubt. However, we have no reaſon to believe, that they arrived at any great degree of perfection in their art; for tho' the Brewers company, at *London*, were incorporated in the year 1427; and a company of the ſame nature in *France*, many years before, yet it is certain there was no good Beer, either in *France*, or even in *England*, till much later.

The buſineſs of Brewing formerly was, and now generally is, in the hands of men unacquainted with Chemiſtry, and ignorant that their art has any relation to that ſcience, tho' it is, in reality, a conſiderable branch of it: conſequently, from the want of a due knowledge of the elements and in-

inſtruments neceſſary in Brewing, and from never once imagining, that there were certain fixed and invariable principles, on which they ought to proceed, the advances made in this art could not but be ſlow.

In the reign of Queen *Elizabeth*, Malt began to be better made, and Hops to be uſed; by the addition of theſe, the liquor was capable of being longer kept, and thereby had the advantage of being meliorated by time. The ſuperiority of theſe two vegetables, over all others, for the purpoſes of Brewing, being ſoon known and aſcertained, the legiſlative power prohibited the uſe of any thing elſe in the compoſition of beer: a law certainly of the greateſt utility, by which all ſophiſtication was prevented, and our beers rendered the beſt

beſt in *Europe*. But, at the ſame time, a great difference, in point of excellency, ſubſiſted in the ſame, and in different places; and this was chiefly owing to a want of principles, and rules to direct them, according to the variation of Malt in dryneſs, or of the ſeaſons of the year in heat. The ſame fault ſtill ſubſiſts, though the preſent practitioners of the art cannot plead the ſame excuſe; for the Thermometer, by which they ought to govern themſelves, is now brought to perfection; but at that time was only known to the learned, and not ſufficiently improved for vulgar uſe.

The deſigns of all Brewers are, 1. To extract all the fermentable parts of the Malt, in the beſt manner poſſible. 2. To add Hops, in

in ſuch proportions, as experience teaches them will preſerve and meliorate the beer. And, 3. ſuch a proportion of Yeaſt, as to obtain a perfect fermentation.

The generality of Brewers will be ready to alledge, that theſe three particulars are already ſufficiently underſtood; and that it would be a much more uſeful work, to publiſh a remedy for thoſe imperfections, or diſeaſes, ſuch as cloudineſs, &c. that beer is naturally, or accidentally, ſubject to. But if the three deſigns, above laid down, be executed according to the known rules of Chemiſtry, ſuch a remedy will not be wanted; for beer brewed upon clear and evident chemical principles, is neither naturally or accidentally ſubject to cloudineſs, &c. nor to any diſorder whatever.

ever. Premiums have formerly been advertis'd for diſcovering a remedy for cloudineſs in beer: I ſuſpect no remedy can be found adequate to the diſeaſe; but am certain, from experience, that if beer is brew'd according to the rules laid down in this Eſſay, ſuch diſorders will be prevented.

Hence it is evident, that ſome knowledge in Chemiſtry is abſolutely neceſſary to complete the Brewer. It is a great misfortune, that Men, in general, are ſtrongly prejudiced againſt having recourſe to books, for inſtruction in their reſpective trades; and that this prepoſſeſſion is often of ſuch weight as to diſcourage thoſe who attempt the ſhaking it off, and proceeding upon juſt principles, tho' ſucceſs is, and muſt be the happy effect of the one; as failure commonly,

monly, though falſely, reckoned unavoidable, is that of the other.

From true principles may be derived ſuch a method of Brewing, in winter, that the beer ſhall be fit for uſe, at any limitted period of time; and in ſummer with more ſucceſs than generally is done. A better knowledge of fermentation, and the art of regulating it, will eaſily teach this. I do not mean to inſinuate that Brewing can be better carried on in ſummer than in winter; but only, that if neceſſity requires, it may be carried on to a ſufficient degree of perfection, much longer in the ſeaſon, than is uſual.

Before we proceed, it may be neceſſary to explain ſome few technical terms, and the properties of Fire, Air, Water, &c. as far as they relate to

to Brewing. I have not ſcrupled to make uſe of all the aſſiſtance I poſſibly could, from authors who have treated of theſe ſubjects; and whenever I diſſent from them, it was becauſe, to my apprehenſion, Nature evidently did ſo too. The reader will obſerve, that this Eſſay is deſign'd for men unacquainted with Chemiſtry: and that I do not pretend to treat of theſe ſubjects thoroughly, but only to ſay as much as is neceſſary for a Brewer to know.

The Utility of the ſubject is too manifeſt to need any thing to be ſaid on that head: I will only obſerve, that the Brewers, within the Bills of Mortality, conſume yearly more than ſix hundred thouſand quarters of Malt, and nearly forty thouſand weight of Hops.

AN

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AN

ESSAY

ON

BREWING.

An Explanation of the technical Terms in this ESSAY.

AS this Eſſay is deſigned, as was hinted before, for the ſervice of men, who, in general, are unacquainted with chemiſtry and technical terms; it has been thought adviſeable to avoid all

terms of art, as far as the nature of the work would admit of it, and to prefix an explanation of thoſe that neceſſarily occur.

ACIDS. By acids are meant all thoſe things which taſte ſour, as vinegar, lemons, ſpirit of nitre, ſpirit of ſalt, *&c.* An acid enters, more or leſs, into the compoſition of all vegetables, and is produced by, or rather is the laſt effect of fermentation. Mixed in a due proportion with an alkali, it conſtitutes a neutral ſalt, that is, a ſalt wherein neither the acid nor the alkali prevail. Acids are frequently termed acid ſalts, tho' generally they appear under a fluid form. Due regard ought to be had to the univerſal acid ſuppoſed conſtantly to circulate in the atmoſphere.

ALKALI,

ALKALI, or alkaline ſalts, are ſalts of a nature directly contrary to acids, and always manifeſting themſelves by fermenting therewith: they have an urinous taſte, are produced from the aſhes of burnt vegetables, and by ſeveral other means.

AIR, is a thin, elaſtic fluid, ſurrounding the globe of the earth, imperceptible to all our ſenſes, except that of feeling: it is abſolutely neceſſary to the preſervation both of animal and vegetable life.

ALCOHOL, is the pure ſpirit of wine, without the leaſt particle of water or phlegm.

ANIMALS, are organized living bodies, endued with ſenſation. Minerals are ſaid to grow and increaſe,

Plants to grow and live, but animals only have ſenſation. Animal ſubſtances cannot ferment.

ATMOSPHERE, is that vaſt collection of air, with which the earth is ſurrounded to a conſiderable height.

ATTRACTION, an indefinite term, applicable to all actions whereby bodies tend towards one another, whether by virtue of their weight, magnetiſm, electricity, impulſe, or any other latent power. It is not therefore the cauſe determining the bodies to approach, that is expreſſed by the word attraction, but the effect itſelf. The ſpace through which this power extends, is called the ſphere of attraction.

BREW-

BREWING, is the operation of preparing beers and ales from malt.

BOILING, may thus be accounted for. The minute particles of fuel, being by fire detach'd from each other, and becoming themſelves fire, paſs through the pores of the veſſel, and mix with the fluid; theſe being perpetually in an active ſtate, communicate their motion to the quieſcent water: hence ariſes, at firſt, a ſmall inteſtine motion in the water; and from a continued action in the firſt cauſe, the effect is increaſed, and the motion of the water continually accelerated; ſo that, by degrees, it becomes ſenſibly agitated; but the particles of fire acting on the particles that compoſe the loweſt ſurface of the water, give them an im-

pulſe upwards, by rendering them ſpecifically lighter, ſo as to determine them to aſcend according to the laws of equilibrium; hence there is a conſtant flux of water from the bottom to the top of the veſſel, and reciprocally from the top to the bottom; from whence we learn the reaſon, why the water is hot at top ſooner, than at the bottom. But as an equal heat cannot be diſtributed thro' the whole, the thermometer can be of no ſervice here; on which account it is better for brewers to heat a certain quantity juſt to the act of boiling, and temper it, by adding a ſufficient quantity of cold water. Boiling water is incapable of receiving any increaſe of heat, tho' acted on by ever ſo great a fire, and riſes, according

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ing to *Farenheit*'s Scale, to 212 degrees.

CLOUDY BEER, is a term made uſe of by brewers, to expreſs ſuch beers, as, from the violent heat of the water they have been brewed with, are loaded with more oils than could be abſorb'd by the water; from whence a muddy and grey oil is ſeen floating on the ſurface of the beer, though the body of the liquor is often tranſparent. This is frequently in great quantity, and exceeds the power of any known menſtruum.

COHESION, the action by which the particles of the ſame body adhere together, as if they were but one.

COLD, its greateſt degree is not known; it is a relative term in oppoſition to Heat; the colder a body is, the leſs is the agitation of its internal parts.

COLOUR, is that quality in any body, which cauſes that ſenſation we perceive when we look on a colour'd object. A greater or leſs degree of heat, cauſes different colours in moſt bodies; and from a due obſervation of the colour of malt, we may determine with what degree of heat it has been acted upon.

CYLINDER, a ſolid body, ſuppoſed to be generated by the rotation of a parallelogram. A gardener's roller is a cylinder.

EARTH,

EARTH, is a foſſil, and terreſtrial matter, whereof our globe partly conſiſts.

EBULLITION, is the boiling or bubbling of water, or any other liquor, when the fire has forced a free paſſage through it. Brewers ſuppoſe water to be juſt beginning to boil, when they perceive a portion of the water forced from the bottom in a right line, ſo as to diſturb the ſurface: when the liquor is in this ſtate, they call it, *through*, or upon the point of Ebullition.

DENSITY. By denſity is meant, the cloſeneſs, compactneſs, or near approach of the parts of a body to one another: the more a body weighs in proportion to its bulk, the greater is

is its denſity. Gold is ſaid to be the denſeſt body in nature, becauſe no body, of the ſame bulk, weighs ſo much.

EFFERVESCENCE, is a ſudden agitation, ariſing in certain bodies upon mixing them together; which agitation generates heat.

EXTRACT. If the principal parts of a body are ſeparated from the reſt (or the more uſeleſs) by cold or hot water, theſe parts, collected together, are called an *Extract*.

EXPANSION, is the ſwelling or increaſe of the bulk of bodies, from heat, or any other cauſe.

FERMENTATION, is a ſenſible internal motion of the particles of a compound

compound fluid: by the continuance of this motion, the particles are gradually remov'd from their former ſituation, and, after ſome viſible ſeparation, join'd together again in a different order or arrangement, ſo as to conſtitute a new liquor. No liquors are capable of inebriating, except thoſe that have been fermented.

FIRE, according to *Boerhaave*, is ſomething unknown, which has the property of penetrating and dilating all ſolid and fluid bodies.

FREEZING POINT, is the degree of cold at which water begins to be form'd into ice, which, according to *Farenheit*'s ſcale, is 32 degrees.

FROST, is when the air is in ſo cold a ſtate as to convert the watery particles,

particles, that float in it, into ice: to what degree this may be continued, or how much cold may be increaſed, is unknown; an artificial cold has been excited as far as 72 degrees below 0, that is, 104 degrees below the freezing point.

HEAT, one of the ſecondary qualities of bodies, produced by fire, and oppos'd to Cold.

ISINGLASS, a preparation from a fiſh call'd Huſo, ſomewhat bigger than the Sturgeon; a ſolution of which, in ſtale beer, is us'd to fine or precipitate other beers: it is imported from *Ruſſia* by the *Dutch*, and from them to us.

LIGHT, conſiſts of particles of matter inconceivably ſmall, capable of exciting

exciting in us the ſenſation of colours, by being reflected from every point of the ſurface of luminous bodies; but, notwithſtanding they are ſo exceeding ſmall, Sir *Iſaac Newton* found means to divide a ſingle ray into ſeven diſtinct parts, *viz.* red, orange, yellow, green, blue, indigo, and violet.

MALT, in general, is any ſort of grain, firſt germinated, and then dried: that generally us'd is made of barley, which experience has found to be the fitteſt for this purpoſe, as being the medium between the richeſt and the weakeſt grain.

MUSTS, are the unfermented juices of grapes, or any other vegetable ſubſtances.

MEN-

MENSTRUUM: any body, as water, which, in a fluid or ſubtiliſed ſtate, is capable of interpoſing its parts between the ſmall parts of other bodies, is called a menſtruum, or that which has the power diſſolving or extracting. Salts, in ſome caſes, are very uſeful to ſtrengthen the menſtruums, but not in the proceſs of brewing, the power of hot water being more than ſufficient to extract the fermentable parts, and theſe are the only uſeful ones.

OIL, is an unctuous, inflammable ſubſtance, drawn from ſeveral animal and vegetable ſubſtances.

PRECIPITATION. Iſinglaſs diſſolved in beer, renders it a glutinous and heavy body; this put into the beer in-

intended to be fined, carries down, by its weight, all thoſe ſwimming particles which prevent its tranſparency; and this act is call'd fining, or precipitation.

SALTS, are ſubſtances which readily diſſolve in water, are ſharp and pungent to the taſte, and greatly diſpos'd to unite with earth, ſo as to appear in a ſolid form, as common ſalt, alum, and other ſalts do. Acid ſalts taſte ſharp as vinegar, lemon juice, *&c.* Alkaline ſalts are urinous: and Neutral ſalts, being compos'd of both, are properly neither acid nor alkaline.

SUGAR, or SACCHARINE SALTS, are ſaid to be acids ſmooth'd over with oil; which compoſition yields a ſweet taſte:

taſte. All vegetable ſweets are capable of fermenting ſpontaneouſly when crude; when boil'd, they require an addition of yeaſt to make them ferment. Malt, or its extracts, have all the properties of ſaccharine ſalts.

SULPHUR. Though by ſulphur is commonly underſtood a mineral ſubſtance, yet, in chemiſtry, it is frequently us'd to expreſs the oils of vegetables.

SOAP and SAPONACEOUS JUICES. Common ſoap is made of oil mix'd with alkaline ſalts: this mixture cauſes a froth on being agitated in water. The oils of vegetables are, in ſome degree, mix'd with their ſalts; and though the ſalts of vegetables are un-

undoubtedly acid, and not alkaline, while the vegetable is in being, yet *Boerhaave* calls their juices ſaponaceous. No juices are ſuppos'd to be capable of vegetable fermentation, but ſuch as are ſaponaceous.

THERMOMETER, is an inſtrument for meaſuring the increaſe and decreaſe of heat and cold; but it is of ſuch uſe in the brewery, as to merit a farther explanation in an article by itſelf.

VEGETABLE, a term applied to plants, conſider'd as capable of growth, having veſſels and parts for this purpoſe, but generally ſuppoſed to have no ſenſation.

VINEGAR, is an acid penetrating

liquor, prepar'd from wine, beer, cyder, or a Muſt which has been fermented as far as it was capable; vinegar being the produce of the laſt ſtage of fermentation.

VITRIOL, in general, is an acid found in the body of the earth, mix'd either with iron, copper, or zinc. 'Tis not this concrete, but the oil, or ſpirit of vitriol, that is us'd in the brewery, in order to precipitate or fine brown beers that are ſtubborn or nearly cloudy. A pound is ſometimes put into a butt; though four ounces ſhould never be exceeded in that quantity.

WATER, is a very fluid, ſcentleſs, taſteleſs, colourleſs, tranſparent liquor.

WINE,

WINE, a briſk, agreeable, ſpirituous and cordial liquor, drawn from vegetable bodies, and fermented. In this ſenſe beers and ales may be called, and really are, barley wines.

WORT. Worts, or Muſts, may be ſaid to be ſynonimous terms; the firſt uſually applied to the unfermented extracts of Malt, as the other is to the expreſſed juices of vegetables.

SECTION I.

Of FIRE.

THough Fire is the chief cauſe and principle of almoſt every change in bodies; and though the untaught in chemiſtry imagine, that they thoroughly underſtand its nature, yet certain it is, that there is nothing more incomprehenſible, or that eludes our niceſt reſearch ſo much. The ſenſes are very inadequate judges of it; the eye may be deceived, and ſuppoſe no Fire in a bar of iron, becauſe it does not appear red, though, at the ſame time, it may contain enough to generate pain: the touch is no poſitive proof, for

for a body colder than ourſelves, though, perhaps, containing numberleſs particles of heat, will feel cold.

The great and fundamental difference among philoſophers, in reſpect to the nature of Fire, is, whether it be originally ſuch, formed by the Creator himſelf at the beginning of things; or whether it be mechanically producible in bodies by inducing ſome alteration in the particles thereof. It is certain, that heat may be generated in any body by attrition; but whether it exiſted there before, or was cauſed immediately by the motion, is a matter of no great import in this Eſſay; for the effects, with which alone we are concerned, are ſtill the ſame.

Fire expands all bodies, both ſolid and fluid. If an iron rod, juſt capable of paſſing thro' a ring of the ſame metal, is heated red-hot, it will be increaſed in length, and ſo much ſwelled as not to be able to paſs thro' the ring, as before: if a fluid is put into a bellied glaſs, with a long ſlender neck, and properly marked, the fluid, by being heated, will manifeſtly riſe to a conſiderable height.

The expanſion of fluids, by heat, is different, in different fluids; and may, in general, be ſaid to be in proportion to their denſity. Pure rain water, gradually heated, is expanded $\frac{1}{20}$ of its bulk, ſo that 85 gallons of boiling water will, when cold, meaſure no more than 84; and 85 gallons of boiling wort will not yield ſo much,

much, becauſe the expanſion is greater than that of water, in proportion as the wort is a denſer liquor than water: hence we ſee the reaſon why a copper, containing a given number of barrels of boiling wort, will not produce the ſame number of barrels of beer when cold.

Bodies are weakened or looſened in their texture by fire: that the action of fire promotes the diſſolution of bodies, is evident, for even the hardeſt, by an increaſed degree of it, will liquify and run; and Vegetables are reſolved and ſeparated by it into their conſtituent parts when dried. It muſt be owned, Vegetables become rigid or ſtiff; but this is not owing to the fire, conſidered as lodged in the ſolid parts,

but to its evaporating the aqueous ones; in which ſenſe alone Fire can be ſaid to ſtrengthen ſome bodies that were before weak.

That the texture of bodies ſhould be looſened by Fire, is a neceſſary conſequence of expanſion; for a body cannot be expanded but by its particles receding farther from one another; and if the particles be not able to regain the ſituation they had when cold, the body will remain looſer in its texture, than before it ſuffered the action of Fire: and this is the caſe of barley when malted.

Fire may be conveyed through moſt bodies, as air, water, aſhes, ſand, *&c.* The effect ſeems to be different, according to the different con-

conveyances. A difference appears between boiling and roaſting, yet they anſwer the ſame purpoſe, that of preſerving the ſubject; and this, in proportion to the degree of heat it hath ſuffered. Malts, the more they are dried, the longer are they capable of maintaining themſelves in a ſound ſtate, and the liquor brewed with them will, in proportion to ſuch dryneſs, keep the longer ſound. Water applied to Malt to make an extract, provided it does not exceed a certain degree of heat, the hotter it is, the more durable and ſounder will the extract be.

The laſt conſideration of fire or heat that relates to brewing is, the knowledge of its different degrees, and

and how to regulate them: till of late, chemiſts, and all others, were much to ſeek in this reſpect; they diſtinguiſhed more or leſs Fire in a very vague and indeterminate manner; as the firſt, ſecond, third, and fourth degree of heat, meaning no preciſe heat, or heat meaſured by any ſtandard; but by the invention of the Thermometer, we are enabled to regulate our Fires with the utmoſt preciſion. Thermometers are formed on different ſcales; and therefore when any degree of heat is mentioned, in order to avoid confuſion, the ſcale made uſe of ſhould be mentioned. I have conſtantly uſed *Fahrenheit*'s, as it is the moſt perfect, and the moſt generally received. According to this inſtrument, 32 degrees

grees is the freezing point, or where water first begins to harden into ice; from 32 degrees to 60, may be said to be different degrees of vegetation, according to the different plants that receive such heats; the 40th degree is marked by *Boerhaave*, as the first fermentable heat, and the 80th as the last; 47 degrees I have found to be the medium heat of *London* throughout the Year in the shade; 98 degrees is said to be that of our bodies when in health, as from 105 to 112 are its degrees when in a fever; at 175 degrees the purest and highest-rectified spirits of wine boil, and at this degree I have found well grown Malt to charr; at 212 degrees water boils; at 600 degrees, quicksilver and oil of vitriol. Iron,

Gold,

Gold, Silver, and all other Metals in fuſion exceed this heat; greater ſtill than any of theſe is the heat in the focus of the burning lens or concaves made by Vilette, and Tſchirnhauſen's; theſe are ſaid to volatilize metal, and vitrify bricks. Thus far experiments have reached; but how much more, or how much leſs, the power of this element is, will probably be for ever unknown.

SECTION

SECTION II.

Of AIR.

NONE of the operations, either of Nature or Art, can be carried on without the action or aſſiſtance of Air. It is the principal agent in fermentation; conſequently its properties and powers, ſome of them at leaſt, ought to be well underſtood by brewers.

By Air we mean a fluid, ſcarcely perceivable by our ſenſes, and diſcovering itſelf only by the reſiſtance it makes to bodies. We find it every where incumbent on the ſurface of the globe, extending to a conſiderable, but determinate height, and

and commonly known by the name of the atmoſphere. The weight of air is to that of water as 1 to 850, and its gravitating force equal to the preſſure of a column of water 33 feet high; ſo that an area of one foot ſquare receives from air a preſſure equal to 2080 pounds weight.

Elaſticity is a property appertaining to only one of the four elements, namely, Air, and is in proportion to the compreſſing weight. We ſcarcely find this element (any more than the others) in a pure ſtate: one thouſandth part of common Air, ſays *Boerhaave*, conſiſts of aqueous, ſpirituous, oily, ſaline, and other particles ſcattered through it, which are not compreſſible, and are, in general, preventive of fermentation, conſequently

quently where the Air is pureſt, fermentation is beſt carried on. He likewiſe tells us, "It is clear, that "the ultimate particles of Air co-"here together, ſo as not eaſily to "inſinuate themſelves into the ſmall-"eſt pores either of ſolids or fluids;" from whence thoſe acquainted with brewing eaſily account why hot water, which forces ſtrong and pinguious extracts from Malt, prevents fermentation, as oils are an obſtruction to the free entrance of the Air; and from an analogous reaſon, why, in weak extracts fermentation is ſo much accelerated that the whole ſoon becomes ſour.

Air (like other ſubjects) is expanded or rarefied, and acquires a greater degree of elaſticity, in proportion

portion to its heat; conſequently the hotter the ſeaſon, the more active and violent will fermentation be.

Air abounds with water, and is perpetually penetrating and inſinuating itſelf into every thing capable of receiving it. Its weight, or gravitating force, muſt neceſſarily produce numberleſs effects; the water contained in Air is rendered more active by its motion; the ſalts and ſaponaceous ſubjects it meets with are looſened in their texture, and, in ſome degree, diſſolved by it: as theſe are the principal conſtituent parts in Malt, the reaſon is obvious why thoſe that are old, or have lain a proper time expoſed to the influence of the Air, diſſolve more readily,

dily, or, in other words, yield a more copious extract, than others.

By means of this penetrating and active power in the Air, all bodies in a paſſive ſtate, expoſed thereto a ſufficient time, become of the ſame degree of heat with the Air itſelf. On this account the water lying in the backs uſed by brewers, may be ſaid to be nearly of the ſame degree of heat as the Thermometer ſhews the open Air in the ſhade to be, except when this inſtrument indicates a cold below the freezing point, or 32 degrees: for if the water was then as cold as the Air, it would become ice: in this circumſtance it may more properly be accounted as hot as 33 degrees; for water will not immediately become as cold as the

Air, on many accounts, ſuch as its not having been long enough expoſed thereto, its being pumped out of deep wells, &c.

Air is not eaſily expelled from bodies, either ſolid or fluid: water requires two hours boiling to be diſcharged of the greateſt part of its Air. That Air may thus be diſcharged by heat, appears from this, that water thus boiled, inſtead of having any Air-bubbles when it freezes, as ice commonly has, will become a ſolid maſs like cryſtal.

As Air is rendered more active by being joined to Water, that Water which has endured the Fire the leaſt time, provided it be hot enough, will make the ſtrongeſt extract.

Worts,

Worts, or Muſts, as they contain great quantities of ſalts and oils, are denſer bodies than common water, and therefore require a greater degree of heat to make them boil; conſequently more Air is expelled by boiling worts, in a given time, than by boiling water in the ſame time; and as Air does not inſtantaneouſly re-enter thoſe bodies, tho' cold, they would never ferment of themſelves; and were it not for the ſubſtitute of yeaſt, to ſupply the deficiency of the Air loſt by boiling, they would ſour or putrify for want of an internal elaſtic Air, which is abſolutely neceſſary to fermentation.

Air is more eaſily diſlodged from hot than from cold water, becauſe the weight of the atmoſphere is leſs

on the former than the latter: but though there is Air in every fluid, it differs in quantity in different fluids; ſo that no rule can be laid down for the quantity of Air worts ſhould contain: probably the quantity ſufficient to ſaturate one ſort, will not be an adequate proportion for another.

Laſtly, Air encompaſſes, is in contact with, confines, and compreſſes all bodies; inſinuates itſelf into their penetrable paſſages, and exerts all its power as well on ſolids, as on fluids; and finding in bodies ſome elements to which it has a tendency, unites with them. By its weight and perpetual motion it ſtrongly agitates the parts of bodies in which it is contained, rubs, and intermixes them in-

intimately together, diſuniting ſome, and joining others, and thereby producing very ſingular effects, not eaſily accompliſhed by any other means. That this element has ſuch ſurpriſing powers, is evident from the following experiment. "Fermentable parts, duly prepared and diſpoſed in the vacuum of Mr. *Boyle*'s Air-pump, will not ferment, though acted upon by a proper heat; but, diſcharging their Air, remain unchanged.

SECTION III.

Of WATER.

AS Water is perpetually an object of our ſenſes, and made uſe of for moſt of the purpoſes of life, many people imagine, that they perfectly underſtand its nature: but they who have inquired into it with the greateſt care, find it very difficult to form a right notion of it, becauſe it is no eaſy matter to ſeparate Water from other bodies, or other bodies from Water. Hartſhorn, by being long dried, reſiſts a file more than iron; yet, on diſtillation, yields much Water. I have already obſerved, that Air is intimately mixed with

with it; how is it poſſible then ever to obtain Water perfectly pure?

In its moſt perfect ſtate, we underſtand it to be a liquor very fluid, inodorous, inſipid, pellucid, and colourleſs, which, in a certain degree of cold, freezes into a brittle, hard, glaſſy ice: this furniſhes us with another reaſon, why it is abſolutely impoſſible to have water intirely free from every thing elſe, becauſe, while it ſubſiſts in a fluid ſtate, it contains a conſiderable degree of heat or fire.

Though lightneſs is reckoned a perfection in water, yet its certain weight is with great difficulty determined: fountain, river, or well waters, by their admixture with ſaline,

ſaponaceous, and vitriolic ſubſtances, are rendered much heavier than in their natural ſtate; and different degrees of heat, by varying the expanſion, muſt affect the weight of water. A pint of rain-water, ſuppoſed to be the pureſt, is ſaid to weigh 15 ounces, 1 drachm, and 50 grains; but the weight is different in different ſeaſons of the year.

A ſecond property of Water, which it has in common with other liquors, is its fluidity; and this is ſo great, that a very ſmall degree of heat above the freezing point, makes it evaporate. Few brewers, I believe, know how great a proportion of the quantity of water they uſe in brewing, is loſt by evaporation. The

purer

purer the water, the more readily it evaporates; ſo that ſea-water, which is ſuppoſed to contain one fortieth part of ſalt, waſtes much leſs than purer water, and more forcibly reſiſts the effects of Fire. Notwithſtanding which, as Fire ultimately divides moſt bodies, and has the property of ſeparating the denſe parts from the rare, a ſtrong and continual ebullition may be a means of ſeparating, in ſome meaſure, the impurities of the Water from the Muſt.

The ultimate particles of Water, *Boerhaave* believed to be much leſs than thoſe of Air, as water paſſes thro' the inviſible pores and interſtices of wood; which never tranſmit the leaſt elaſtic air: nor is there, ſays he, any known fluid, (Fire excepted, which pene-

penetrates every thing) whoſe parts are more penetrating than thoſe of water; but as water is not an univerſal diſſolver, there are veſſels which will contain it, though they will not contain even the thick ſyrup of ſugar, for ſugar makes its way by diſſolving the tenacious and oily ſubſtance of wood; which water cannot.

Water, when fully ſaturated with Fire, is ſaid to boil, and is then under a ſtrong ebullition; in that ſtate it occupies $\frac{1}{15}$ degrees more ſpace than when cold: ſo that a brewer who would be exact, when he intends to reduce his liquor to a certain degree of heat, muſt allow for this expanſion, abating therefrom the quantity of ſteam exhaled.

As

As Water, by boiling, may be ſaid to be filled or ſaturated with Fire, ſo may it with any ſubject capable of being diſſolved therein. Tho' Water will diſſolve only a given quantity of any body ſoluble in it; yet, at the ſame time, it will diſſolve a certain proportion of ſome other body: for four ounces of pure rain-water will diſſolve but one ounce of common ſalt; though after taking this as the utmoſt of its quantity, it will ſtill receive and diſſolve two ſcruples of another kind of ſalt, *viz.* pulverized Nitre. In the ſame manner the ſtrongeſt extract of Malt, or Water ſaturated with the ſoluble parts of Malt, is ſtill capable of receiving ſomething from Hops; but in a limited proportion, as is evident from the

the thin bitter pellicle that often ſwims on the ſurface of the firſt wort of brown ſtrong beer, which is commonly over-charged with Hops, by putting the whole quantity into it: the Water not being capable of ſuſpending all that the heat diſſolves, it riſes at top. This may ſerve for a hint, to uſe fewer, or rather to divide them otherwiſe than is generally practiſed.

Boerhaave believed the ultimate particles of Water to be ſolid ſpheres, rigid, perfectly inflexible, and of an adamantine hardneſs: whether this doctrine be true, or not, it is certain, that Water acts very differently, as a menſtruum, according to its different degrees of heat: conſequently its heat is a point of the utmoſt importance with

with regard to brewing, and muſt be properly varied according to the drineſs and nature of the Malt; to its being applied either in the firſt or laſt maſhes; and in proportion alſo to the time the beer is intended to be kept. To this end we muſt have recourſe to the Thermometer, as the only inſtrument capable of numerically determining the power of Heat or Fire.

Nutrition cannot be carried on without Water, though Water itſelf is not the matter of nouriſhment, but only the vehicle.

Water is as neceſſary to fermentation as heat or air: the farmer who ſtacks his hay or corn before it is thoroughly dried, ſoon experiences the

the terrible effects of too much moiſture or water reſiding therein: all vegetables therefore intended to be kept long, ought to be well dried. The brewer ſhould carefully avoid purchaſing Hops that are ſlack bagged, or kept in a moiſt place; or Malt that has been ſprinkled with water ſoon after it was taken from the kiln; for, by means of the moiſture, a fermentation begins, which, for want of a ſufficient quantity of Air, is ſoon ſtopped; but the heat thereby generated, remaining, every ſeed begins to grow, and forms a moſs that dies, and leaves a putrid muſty taſte behind, which always prevails, more or leſs, in the beer.

Water, by ſome, has been accounted an univerſal ſolvent: but, certain

certain it is, it does not act as ſuch on all metals, gems, ſtones, and many other ſubſtances: it does not, in general, diſſolve oils, but is miſcible with highly-rectified ſpirits of wine, or alcohol, which is the pureſt vegetable oil in nature; all ſaponaceous bodies, whether artificial or natural, fixed or volatile, readily melt therein: the ſoluble parts of Malt, being oils and ſalts, are properly ſoaps, and conſequently diſſoluble in this menſtruum; and in ſuch manner, that neither the oil nor ſalt appears ſeparately, but the whole ſeems to compoſe an homogeneous uniform mixture. One particular property of ſaponaceous ſubſtances, well worth our obſerving is, that, by being intimately mixed with oily ſubſtances, reſins, *&c.* they render them miſcible

ble with water; conſequently Hops, which contain a large portion of reſin, will yield their extracts more efficaciouſly by being boiled in wort than in water alone: ſo that all pretended improvements for making extracts of Hops by themſelves in water alone, or keeping a Rob of them againſt dear times, are abſurd and ridiculous. Water not only diſſolves true ſoaps, but, by their aſſiſtance, acquires a power of diſſolving bodies which otherwiſe it could not. A farther proof of this (which every attentive brewer will find) is, that a given quantity of Hops, boiled in a wort by hotter water more ſtrongly extracted, will yield a bitterer liquor, than the ſame quantity boiled in a weaker wort, or in water alone.

When

When a ſaponaceous ſubſtance is diſſolved in water, it lathers, froths, and bears a head; hence, in extracts of Malt, we find theſe ſigns in the underback; but weak and ſlack liquors (the ſalts of the Malt only being diſſolved without a ſufficient quantity of the oils) not being ſaponaceous, yield no froth, and generally let part of the griſt fall undiſſolved in a whitiſh flour: ſomewhat like this happens when the water for the extract is over-heated, for then, as more oils are extracted than are ſufficient to balance the ſalts, the extract is not ſaponaceous; in this caſe the extract comes down with little or no froth or head, as before; but without depoſiting any flour in the underback: hence, tho' the head or froth of the extracts in the under-

back are eſteemed, by many, as ſure ſigns and guides for regulating the progreſs of brewing, we ſee how uncertain ſuch ſigns are, as direct oppoſites exhibit the ſame appearances; and ſhould the heat of the water be increaſed beyond this laſt-mentioned degree, ſo as to impede the action of the Air neceſſary to extract with, (an error by the brewers termed *ſetting the goods*); inſtead of having a good extract, the whole runs into inſeparable clods or lumps, from whence the griſt is ſeldom or never recovered; conſequently, whoever would act with certainty in this art, muſt rely on the Thermometer alone.

This might be a proper place to obſerve the difference between rain, ſpring, river, and pond waters; but as

as the art of brewing is very little, or not at all affected by the difference of waters, if they be equally ſoft, but rather depends on the due regulation of heat; and as ſoft waters are alike, and found in moſt places where brewing is neceſſary; from hence it is evident, that any ſort of beer or ale whatever may be brewed with equal ſucceſs, where Malt and Hops can be procured proper for the reſpective purpoſes. And if hitherto prejudice or intereſt has appropriated to ſome places a reputation for particular ſorts of drinks, it has aroſe from hence: The art being totally defective of principles, the event depended on experience only; and lucky combinations were moſt frequent where the greateſt practice was; and for want of

knowing the true reaſon the different properties obſerved in the ſeveral drinks were attributed to the water; but juſt and true principles, followed by as juſt a practice, renders the art univerſal. This truth would appear in a ſtronger light, were I to extend the obſervations farther on this element; but as the ſubject of Water is fully treated of by *Boerhaave*, *Shaw*, and *Hales*, it would be tedious to add any thing more upon it.

SECTION

SECTION IV.

Of EARTH.

BOERHAAVE defines Earth to be a ſimple, hard, friable, foſſil body, fixed in the fire, but not melting in it, nor diſſoluble in water, alcohol, oil, or air. Theſe are the characters of pure Earth; which no more than any of the other elements comes within our reach, free from the admixture of the others; but as it is never made uſe of in brewing, except ſometimes for the purpoſes of precipitation, it is unneceſſary to ſay any thing more upon it: whoever deſires to be more informed concerning it, may conſult

Boerhaave, and the authors before-mentioned.

SECTION V.

Of the THERMOMETER.

THE Thermometer is an inſtrument for meaſuring the increaſe and decreaſe of heat and cold; and, by doing it numerically, fixes in our minds the value of any degree: if bodies of ſeveral properties are brought to one denomination, though each poſſeſs different degrees of heat, it teaches us to diſcover what degree they will arrive at when thoroughly blended together, ſuppoſing effervescence to have no ſhare in their heat.

The

The inventor of this admirable inſtrument is not certainly known; however, the merit of the diſcovery has been aſcribed to ſeveral great men, of different nations, in order to do them, or their countries honour. It came to us, from *Italy*, about the beginning of the ſixteenth century. The firſt inventors were far from bringing this inſtrument to its preſent degree of perfection; it was not then hermetically ſcaled, conſequently the contained fluid was, at the ſame time, under the influence of the weight of the air, and that of expanſion by heat. The academy of *Florence* added this improvement; which ſoon made them more generally received: but ſtill the inſtrument laboured under many imperfections: the high-

eſt degree of heat of the *Florentine* Thermometer was fixed from the heat of the ſtrongeſt rays of the ſun in that country; this vague determination, varying in almoſt every place, and the want of a fixed and univerſal ſcale, have rendered all the obſervations, made with ſuch inſtruments, uſeleſs to us.

Boyle, *Halley*, *Newton*, and ſeveral great men thought this inſtrument ſo worthy of their attention, as to endeavour to fix two invariable points, to reckon from, and to obtain a proper diviſion. Mr. *Amontons* is ſaid to have diſcovered the uniformity of the degree of boiling water; and made uſe of this for graduating his Thermometers; but *Fahrenheit* found, that the preſſure of the

the Air would vary this, in its greateſt latitude, ſix degrees; and therefore concluded that a Thermometer, made at a time when the Air is in its middle ſtate, may be ſuppoſed ſufficiently exact for almoſt every purpoſe. As ſoon as this degree of heat, *viz.* that of boiling water, was ſettled, many means were propoſed to determine another as certain: the degree of temperature was thought, by many, a proper one; but what that degree truly was, became difficult to determine; at laſt the freezing point of Water offered itſelf, and though ſome doubts aroſe with Dr. *Halley*, and others, whether Water conſtantly froze at the ſame degree of cold, yet Dr. *Martine*, by his ſeveral experiments, proving this

to

to be beyond all doubt, it has been received for as fixed a truth, as that of boiling Water. Theſe two degrees being thus eſtabliſhed, nothing remained but the diviſion of the intermediate ſpace on ſome ſcale that could be univerſally received.

The matter wherewith Thermometers were to be made, became the object of farther ſearch: Sir *Iſaac Newton* employed, for this purpoſe, linſeed oil: but this was objected to, as being an unctuous body, and more apt to adhere to the ſides of the glaſs; and, on account of its being ſuddenly affected by cold, for want of thoſe parts which thus adhered to the ſides, did not ſhew the true degree.

Tinged

Tinged Water was employed by others; but this freezing when *Fahrenheit*'s Thermometer points 32 degrees, was, from thence, incapable of denoting any cold more intenſe.

Spirits of Wine, which endure a great deal of cold without ſtagnating, were next employed; but this liquor being ſuſceptible of no greater degree of heat, than where *Fahrenheit*'s ſcale ſhews about 175 degrees, was not capable of being uſed where boiling Water was concerned.

The only fluid then, which could beſt anſwer every purpoſe, was Mercury; this never has been known to freeze, and will not boil under a heat of 600 degrees; beſide, it is free

free from every inconvenience attending other liquids.

I do not recollect to have heard, or to have read, that the exterior form of thermometers has undergone any very conſiderable alterations; but as the inſtrument is entirely founded on the doctrine of expanſion, *viz.* that heat or fire expands all bodies, as cold condenſes them, there was a neceſſity of employing a fluid eaſy to be dilated, whoſe bulk ſhould be ſeated in one part, but, being expanded by heat, ſhould ſhew the expanſion by entering into ſome fine tube, or capillary cylinder, ſo ſmall that its motion ſhould be ſpeedy and perceptible. Some Thermometers have been conſtructed with bulbs compoſed of a larger cylinder: now

now they are generally made globular; the ſmaller the bulb is, undoubtedly the ſooner is it heated through, and the finer and ſmaller the tube, the greater will be the length of it, and the more diſtinct the degrees: but another improvement was ſtill wanting, as it is ſcarcely poſſible any glaſs cylinder, ſo very ſmall, can be perfect; but if the quickſilver, during the expanſion, as in this caſe it muſt, paſſes through ſome parts of the tube wider than others, the degrees will be ſhorter in the former, and longer in the latter; conſequently, if the diviſions in ſuch a tube are made equal between the boiling and freezing points, the Thermometer, thus graduated, cannot be true: to rectify this, the ingenious Mr. *Bird*, of *London*, put into the tube about the length

length of an inch of Mercury; and meaſuring, with a pair of compaſſes, the exact length of this body of quickſilver in one place, he moved it about from one end to the other, carefully obſerving, in the ſeveral places, how much it increaſed or diminiſhed in length, and thereby aſcertained where, and how much the degrees were to be varied. By this means his Thermometers are perfectly accurate, and exceed all that were ever made before.

I ſhall not trouble my reader with the number of calculations that have been made to expreſs the quantity of particles the matter contained in the bulb is ſuppoſed to conſiſt of, in order to determine the quantity dilated: this Dr. *Martine* ſeems to think is more

more curious than uſeful; it is ſufficient, for our purpoſe, to know how the beſt Thermometers ought to be conſtructed: they who have leiſure and inclination, may be agreeably entertained by the author laſt cited.

By obſerving the riſe of the Mercury in the Thermometer, during any given time; as, for inſtance, during the time of the day, we aſcertain the degree and value of the heat of every part of the day: by repeated experiments it appears, that the medium heat of the whole day is uſually indicated at a ſtated time, *viz.* at eight o'clock in the morning, if the inſtrument is placed in the ſhade, in a northern ſituation, and out of the reach of culinary, or any other accidental heat.

Though

Though Water is not ſo readily affected by heat and cold as the Air, yet as all bodies, that are long expoſed to the Air, become of the ſame degree of heat with the Air itſelf, no great error can ariſe from eſtimating Water, in general, to be of the ſame heat as the Air, at eight o'clock in the morning, in the ſhade.

The Thermometer teaches us, that the heat of boiling Water is equal to 212 degrees; and, by calculation, we may learn what quantity of cold Water is neceſſary to bring it to any degree we chuſe; ſo that though the inſtrument cannot be uſed in large veſſels where the Water is heating, yet, by the power of numbers, the heat may be aſcertained with the greateſt accuracy. The rule is this:

Multiply

Multiply 212, the heat of boiling Water, by the number of barrels of hot Water (ſuppoſe 22;) and the number of barrels of cold Water to be added to the former (ſuppoſe 10 barrels) by the heat of the Air at 8 o'clock (ſuppoſe 50;) add theſe two products together, and divide by the ſum of the barrels; the quotient ſhews the degree of heat of the Waters mixed together.

212 heat of boiling water. 50 deg. of heat at 8.
22 barrels of hot water. 10 bar. of cold water

	424		500
	424		
22	4664		
10	500		
Sum 32 of barrels.	5164	161 degrees will be the heat of the water when mixed together.	
	32		
	196		
	192		
	44		
	32		

The calculation may be extended to three or more bodies, provided they be brought to the ſame denomination. Suppoſe theſe 32 barrels of Water to be uſed where there is a griſt of 20 quarters of Malt: if theſe 20 quarters of Malt are equal in bulk to 11 barrels of Water, and the Malt, by having lain expoſed to the Air, is of the ſame degree of heat with the Air, in order to know the heat of the Maſh, the calculation muſt be thus continued.

161 heat of Water. 50 deg. of heat of Malt.
32 bar. of Water. 11 bar. the bulk of Malt

322 550
483

32 Water 5152
11 Malt 550

43 | 5702 | 133 degrees the heat of the Maſh.
43··

140
129

119
129.

We ſhall meet hereafter with ſome incidents, which occaſion a difference in the calculation, but it will be time enough to mention them by and by.

The Thermometer, by ſhewing the different degrees of heat of each part of the year, ſhews us, at the ſame time, how much, more or leſs hot, the extracts for common ſmall beer ought to be; what quantity of Hops ought to be uſed at different times; how much Yeaſt is requiſite, at ſuch times, to carry on a due fermentation; and even the length of the time the Worts ought to boil: and indeed, without this knowledge, Beers, though brewed in their due ſeaſon, cannot be regularly fermented, and whenever they prove good, it is by accident.

Beers are depoſited in cellars, to prevent their being affected by the variation of heat and cold in the external air: by means of the Thermometer the heat of theſe cellars is aſcertained, the temper of the liquor, and whether it will, ſooner or later, come forward, determined.

The brewing ſeaſon, and the reaſons why ſuch ſeaſon is fitteſt for brewing, can only be determined by this inſtrument; it points out likewiſe our chance for ſucceſs ſometimes in the hotteſt months.

All vegetable fermentation is carried on in heats between 40 and 80 degrees; we are, by this inſtrument, taught to put our Worts together at ſuch a temperature, that they ſhall neither

neither be evaporated by too great heat, nor retarded by too great a degree of cold.

If curioſity ſhould lead us ſo far, we might likewiſe determine, by it, the particular ſtrength of each Wort, or of every Maſh; for if Water boils at 212 degrees, Oils at 600, and Worts be a compoſition of Water, Oil, and Salt, the more the heat of a boiling Wort exceeds that of boiling Water, the more Oils and Salt muſt it contain, or the ſtronger is the Wort.

A given quantity of Hops, boiled in a given quantity of Water, muſt be ſimilar to the caſe of the Wort juſt now mentioned; and their intrinſic value and goodneſs may in the ſame manner be aſcertained.

The more the Malts are dried, the more do they alter in colour, from a white to a light yellow, next to an amber, then to a high amber; farther on, to a low brown, ſtill encreaſing to a higher, until, at laſt, it become ſpeckled with black; in which ſtate we frequently ſee it: and if more fire or heat is continued, it will charr, and become black. If once we obſerve the degree of heat neceſſary to produce theſe alterations of colour, we ſhall, for the future, by inſpection of the Malt only, know with what degree of fire it has been dried; know immediately what will ſuit our purpoſe, and, with the greateſt accuracy, appoint the heat of the firſt Maſh, a thing of the greateſt conſequence to the right management of the proceſs of brewing.

If

If I had not already ſaid enough to convince the brewer of the utility of this inſtrument, how curious he ought to be in the choice, and how well acquainted with the uſe of it, I would tell him, that the heat gained by the effervescing of Malt, is to be determined by it alone; that heats loſt by maſhing, or by Water in its paſſage to the ton, can be found by no other means; and above all, that there is no other way, with certainty, to know the heat of the tap or extracts; the importance of which will fully appear in the ſequel.

I know very well, that good Beer was made before the Thermometer was known, and ſtill is, by many, who are as entirely ignorant of it, as

if it had never been invented: but this is always by chance; and they cannot but confeſs they frequently fail; whereas, did they but properly apply this inſtrument, they certainly never would. It is juſt as abſurd for a Brewer to refuſe the uſe of it, as it would be for an Architect to throw away his rule, as uſeleſs, becauſe the firſt houſe was, probably, built without one.

SECTION

SECTION VI.

Of the VINE, *its* Fruit *and* Juices.

HItherto we have done little elſe but define, and conſider the properties of the ſubjects concerned in brewing, occaſionally applying them to the art: in the definitions hitherto given of Beers and Wine, we have choſen a diverſity, the better to explain ourſelves, and convey, at the ſame time, a true idea of them: we will now conſider them as ſimilar, or, at leaſt, analogous liquors. All Wines, whether made from corn or fruit, muſt, at the time they are uſed, have their ſolid parts ſo

ſo blended with their fluid, as to make but one taſte, and be ſound, light, and tranſparent: but as this can ariſe only from a due proportion of the fermentable parts, and from a due fermentation itſelf, it is evident, that the act of fermentation ought to be the object of our firſt and ſtricteſt inquiry.

Any fermented vegetable liquor, that in diſtillation yields a ſpirit which will burn, and may be mixed with Water (ſays *Boerhaave)* may be diſtinguiſhed by the name of Wine, whatever vegetable matter it is produced from. Now, as ſuch a ſpirit is produced both from beer and ales, brewing may be juſtly called the art of making Wines from corn. In order to arrive at the knowledge of con-

conducting this art in the beſt manner, let us have recourſe to nature in that liquor, and to that fruit which has wholly engroſſed the name of Wine; and obſerve the properties ſhe employs, and the ſteps ſhe follows in bringing about the proceſs of fermentation.

Moſt of the juices of Grapes have, when fermented, the property of being, in time, as light and pellucid as pure Water; and contain fine ſpirituous parts, ſufficient to cheriſh, comfort, and even inebriate. But theſe properties in their juices, tho' general, are not univerſal; for which reaſon it is neceſſary to examine ſome circumſtances attending the formation and ripening of this fruit; of thoſe ſorts of it, I mean, whoſe

whoſe juices produce a liquor capable of ſupporting itſelf in a ſound ſtate for ſome time.

All Grapes, when they firſt bud forth, are extremely ſour, and when ripe, very ſweet; being originally an acid, which is afterwards ſmoothed over with an oil: with us, in *England*, they are produced under the leaſt degree of heat they are capable of, and diſcover themſelves here, in their firſt ſhape, about *June*, when the medium of the heat of the ſun's beams, and the cold of the night, is nearly equal to 60 degrees, according to *Fahrenheit*'s Thermometer; this therefore is the degree of heat, under which their acid ſalts are formed.

The

The higheſt degree of heat, in ſome countries where Grapes come to perfect maturity, as at *Rome*, is 99 degrees; at *Padua* 92 degrees; at *Montpelier* 88 degrees, in the ſhade; to which, according to Dr. *Liming*'s obſervation, 20 degrees more muſt be added for the greater heat of the ſun's beams: the heat then at *Rome* will be 119 degrees; at *Padua* 112 degrees; at *Montpelier* 108 degrees; and theſe approach nearly to the greateſt degrees of natural heat; for *De Reaumur* has obſerved no higher than 104 degrees, which, with the addition of the 20 above-mentioned, will make the greateſt heat equal to 124 degrees. Hence we may conclude, that 124 degrees is a heat by which their acids are ſtill ſmoothed with

with oils, ſo as to become ſweet; and gaining, by the greateſt heat, the greateſt quantity of oils, they obtain their greateſt power, under this degree, of reſiſting the acids that circulate in the air; or, in other words, obtain their greateſt degree of ſweetneſs. Though the higheſt degree of heat, in the known world, does not exceed 124 degrees, yet there are many countries, as *Jamaica*, *Barbadoes*, &c. that will not generally produce grapes; and whenever the cultivation of the Vine is attempted in thoſe places, it is obliged to be ſhaded and ſcreened from the ſcorching beams of the ſun, which, in its infancy, it is not capable of ſupporting. By comparing the heat of thoſe places with that at *Rome*, *Padua*, and

and *Montpelier*, as before, it will appear, that the want of Grapes is not owing to the heat being too great to ripen them, but becauſe, in thoſe parts of *America*, the heats, being not only great, but conſtant, and nearly uniform all the year, exceed the degree of temperature neceſſary for the firſt production of the fruit.

Hence we learn, that Nature employs leſſer heats to form, than to ripen, the juices of this fruit, or to beſtow on them a power of maintaining themſelves, for ſome time, in a ſound ſtate. And from this we may learn an invariable rule for our government in extracting the virtues from Malt, for any ſort of Beers or Ales whatever. We have inveſtigated the loweſt degree of heat in which Grapes are

are produced, and nearly the higheſt they ever receive to ripen them; and knowing, that ſome climates have a conſtant heat, too great to admit of their being formed, we may, from theſe principles, with certainty ſay, There are certain degrees of heat, with regard to Grapes, which may be called their germinating degrees; and the reſt, ſuperior thereto, their degrees of maturation: and if 60 degrees be the loweſt of the one, and 124 degrees the higheſt of the other; and if a certain power of acids is neceſſary for their germination, which muſt be counterbalanced by an equal power of Oils raiſed by the heat of the ſun for their maturation, or perfect ſtate; then the medium of theſe two numbers, or 92 degrees, may be ſaid to be a degree, at which this fruit

fruit cannot poſſibly be produced. At *Panama* the loweſt degree of heat is 72 degrees, to which 20 degrees added, for the ſun's beams, makes 92 degrees, conſequently no Grapes grow there: if we recollect, that we can ſcarcely make Wine, which will preſerve itſelf, of Grapes produced in *England*, (for our ſun ſeldom raiſes the Thermometer to 100 degrees, and that but for a ſhort continuance) and that the ſun, with us, at ſeveral diſtant terms in ſummer, is ſeen to produce new germinated Grapes, it will confirm all that has been advanced above. Theſe reflections are of uſe in brewing; and likewiſe point out, to us, what parts of our Plantations are fit to produce this fruit, and to what degree of perfection.

I have been the more particular in this point, becauſe there is a great ſimilarity between the growth and ripening of Grapes, and the drying and extracting of Malts. If too ſmall a degree of heat is made uſe of, acidity enſues; if too great, on account of a large quantity of air being expelled by the heat, no extract can be obtained. Nature alone points out, to us, the beſt and wiſeſt rules; in this fruit, ſhe ſhews us, that the power which forms it, is exerted only to a certain number of degrees of heat; and that its maturation likewiſe depends on a ſimilar extent of heat, but greater, and more powerful.

In order to illuſtrate the doctrine, that Grapes are endued with various properties, in proportion to the heat of

of the air they have been expoſed to; let us remember what *Boerhaave* has told us, that, in very hot weather, the oleous or pinguious corpuſcles of the earth are carried up into the air, and deſcending again in the next ſhower, make the rain, in ſummer, very different from that pure ſnow which falls in a hard froſt: it is far more acrid, and diſpoſed to froth; and hence ſummer rain, or rain produced in hot weather, is always fruitful, whereas that in cold is ſcarcely ſo at all. In winter the air abounds with acid parts, and is more compreſſed by cold; in ſummer, as may be ſeen not only from the rain's diſpoſition to froth with acid ſalts, but alſo with oily or pinguious corpuſcles, it is in a more relaxed ſtate. The ſame writer has obſerved, in many places,

that principles which once occupy bodies, are ſo blended one with another, as to be ultimately inſeparable: thus Grapes, by cold, obtain a quantity of compreſſed air, which, when covered with oils attracted into the fruit by a greater heat, becomes, in ſome degree, elaſtic; from hence ariſes (as we ſhall hereafter ſee) part of their fermentable quality: and as Grapes gain alſo acid parts, which cannot, by any natural heat, be intirely removed, but are covered or blended with oils attracted by heat, a ſaccharine ſalt is formed. Now, in proportion as theſe acids are formed more or leſs ſharp, and counterbalanced by a greater or leſs quantity of oils, their juices approach nearer to perfection or ſaponaceouſneſs, and complete the power of fermenting.

ing. A perfect fermentation is the aim of the Wine-maker; and as this cannot be obtained but with juices perfectly ſaponaceous, it follows, that the properties of a true ſapo may be eſtimated by the ſame ſcale and numbers as fermentation; and a ſapo may be ſaid to be true and perfect, when the power of the ſalts therein are equal to the power of the oils, and both moſt intimately blended; from whence Wines ferment, become ſpontaneouſly pellucid, and maintain themſelves ſound a due time. A reflection on the different tendency the Wines of *France*, *Spain*, and the *Madeiras* have to theſe properties, in proportion to the heats they ſuſtain in ſeveral ſtages of growth, and ſome Wines, which come from the *Indies*,

which art can ſcarcely make tranſparent, will evince the truth of this doctrine; ſo that it may well be noted, that chemiſtry has not furniſhed the practical part of the brewery, with a better piece of intelligence than this.

The nature of the ſoil proper for the Vine would, in another work, be a very uſeful enquiry; it will be ſufficient here barely to hint at the effect which nitrous ſoils produce in muſts. The *Portugueze*, when they diſcovered the iſland of *Madeira*, in 1420, ſet fire to the foreſts with which it was totally covered; it continued to burn for the ſpace of ſeven years, after which they found the land extremely fruitful, and yielding

ſuch

ſuch Wines as, at preſent, we have from thence, tho' in greater plenty: now *Madeira* Wines are very difficult to fine, and though this climate is more temperate than the *Canaries*, yet the Wines are obliged to be carried to the *Indies*, and the warmer parts of the Globe, to be purged, ſhook, and attenuated to the ſame degree of fineneſs as other Wines; tho', were the *Portugueze* maſters of fermentation, much, or the whole of this trouble might be avoided. Hence we ſee, that nitrous ſoils will produce Muſts able to ſupport themſelves longer, and reſiſt acidity more than other ſoils under the ſame degree of heat. Theſe conſiderations, and others of a like nature, will partly account for the different taſte we find in this liquor.

Grapes have the ſame conſtituent parts as other vegetables: the difference between them, when in perfection, as to their taſtes and properties, conſiſts in the parts being mixed in different proportions; this ariſes either from their abſorbent veſſels more readily attracting ſome juices than others, or from their growing under different heats, and in different ſoils.

We find (ſays Dr. *Hales)* by the chemical analyſis of vegetables, that their ſubſtance is compoſed of ſulphur, volatile ſalts, water, and earth; which principles are endued with mutual attracting powers; and alſo a large portion of air, which has a wonderful property of attracting in a fixed, or of repelling in an elaſtic, ſtate, with a power ſuperior to vaſt com-

compreſſing forces; and it is by the infinite combinations, action, and reaction, of theſe principles, that all the operations in animal and vegetable bodies are effected.

Boerhaave, who is ſomewhat more particular with regard to the conſtituent parts of vegetables, ſays, they contain an oil mixed with a ſalt in form of a ſapo, and a ſaponaceous juice ariſing from the mixture of water with the former.

It is very difficult to judge, by the taſte or ſight, how ſtrong a *Muſt* is, or, according to *Boerhaave*'s expreſſion, how ſaponaceous it is. In worts the bubbles are durable in proportion to the tenacity of the liquor; in ſtrong worts more; in weak ones, leſs: but this

this is far from determining the degree of saponaceousness; and hence, in brewing, arises the necessity of applying the Thermometer to the extract itself, to determine whether it be properly made. Friction neither adds to, nor takes away from the perfection of a Must; for tho' it generates many air bubbles, yet it neither alters the composition, nor increases or lessens the tenacity.

Grapes, from the nature of their composition, have all the necessary principles to form a sapo; they abound with elastic air, water, oils, acid salts, and even saponaceous juices; but the air, enveloped by the covering of the fruit, lies inactive, till it is moved by some foreign cause: in this confined state it causes no visible

be motion; nor are the principles, thus confined, ſubjected to any apparent impreſſions of the external air, or ſo intimately mixed as when the juices of the fruit are expreſſed; but as a perfect mixture of theſe principles is neceſſary for the formation of a ſapo, it is clear, this cannot be perfected without a free communication of the external air with that contained in the interſtices of the liquor. The air contained in the interſtices of fluids is more in quantity than is commonly apprehended, for Sir *Iſaac Newton* has proved, that Water has forty times more pores than parts; and tho' this poroſity in liquids ſuffers the firſt act of fermentation to ariſe, yet we muſt obſerve, that there are circumſtances under which Muſts cannot ferment, *viz.*

when

when the heat of the Wort, to be fermented, exceeds 80 degrees, or is leſs than 40 degrees; or when the Muſts are ſo overloaded with oils, that the acid parts of the air are too weak to penetrate them; for the ultimate particles of the air, ſays *Boerhaave*, cohere together in ſuch a manner as not eaſily to inſinuate themſelves into ſmall paſſages. Much more might be ſaid on the ſubject of the Grape; but I chuſe to confine myſelf chiefly to thoſe particulars, which have ſome relation to, or may afford us any light in, the art of brewing. The act of fermentation, in all vegetables, is undoubtedly the ſame; let us obſerve then, how it is carried on by Nature in the juice of the Grape, in order to apply many things, that may be learned from thence,

thence, to the business of ales and beers.

SECTION VII.

Of FERMENTATION.

FERMENTATION is that act, by which oils, and earth, naturally tenacious, and rendered still more so by their mixture with acids, are brought to such a degree of fluidity, as to be equally suspended in an homogeneous, pellucid fluid; which, by a due proportion of both principles, is preserved from precipitation and evaporation. According to the accurate *Boerhaave*, a less heat than forty degrees leaves the mass in an inert state, and the particles fall to the

the bottom in proportion to their gravity: a greater heat than 80 degrees would disperse them too much, and leave the residuum a rancid, acrimonious, putrid mass.

In order to point out the cause of Fermentation, let us trace its several stages; and the effect of the air will, in great measure, account for them as they rise. The Must, when just pressed from the Grapes, is a liquid composed of acids, oils of different spissitude, water, earth, and elastic air. These are irregularly ranged, and, if I may be permitted the expression, compose a chaos of Wine. Soon after the liquor is settled, a number of air-bubbles arise, and, at first, adhere to the sides of the containing vessel: their magnitude encreases

creaſes as they encreaſe in number, till at laſt they cover the whole ſurface of the Muſt.

It has been long ſuſpected, and, if I miſtake not, demonſtrated, that an Acid, of which all others are but ſo many different ſpecies, is univerſally diſperſed thro', and continually circulating in the air; and that this is one of Nature's principal agents in maturating and reſolving bodies. Muſt, like other fluids, being porous, the circulating acids are very powerfully introduced into it by the preſſure of the atmoſphere, and in proportion as the pores of it are more or leſs expanded by the heat it is expoſed to. The particles of Acids, ſays Sir *Iſaac Newton*, are endued with a great attractive force,

force, in which their activity consists: by their attractive force they rush towards other bodies, put the fluid in motion, excite heat, and violently separate some particles in such a manner as to generate air, and consequently bubbles.

As soon as the acid particles of the air are admitted into the Must, they act on the oils, and excite a motion somewhat like the effervescence generated when acids and oils come in contact, tho' in a less degree; they also excite heat, by means of which the included elastic air is rarefied, and ascends in bubbles towards the surface: these, by the power of attraction, are drawn to the sides of the vessel; at first they are small and few, but encrease, both in number and

and magnitude, as the effect of the air increaſes, till, at laſt, they ſpread over the whole ſurface. The firſt act then of vegetable Fermentation appears to be, the motion by which part of the elaſtic air is freed from the Muſt. It may, perhaps, be proper to obſerve, that all Muſts, which ferment ſpontaneouſly, contain a quantity of elaſtic air.

Bubbles ſtill continue to riſe after the Muſt is entirely covered with them; and a body of bladders is formed, called, by the Brewers, the head of the drink; which, by retaining the internal heat excited by the motion, accelerates the fermentation. As the number of bubbles increaſe, the head riſes in height,

and continues in this ſtate till the compound particles are ſeparated from one another: after this the bubbles (the Muſt being more attenuated) riſe almoſt in right lines, but not exactly ſo, and thereby force the head to take an uneven and irregular ſhape, ſo that it appears like a beautiful piece of rock-work. It may be preſumed, that at this time the conſtituent parts of the Muſt are diſpoſing themſelves in their due order, and that the interpoſition of the Water keeps not only the ſaline, oily, and ſpirituous parts, but alſo the mucilaginous and earthy ones, in their due arrangement. Heterogeneous bodies, as dirt, ſtraw, corks, &c. are now buoyed out of the Muſt, and ſhould be

be ſkimmed off, leſt, when the liquor becomes more light and ſpirituous, they ſhould ſubſide. As the heat increaſes, the air-bubbles grow larger; ſome not formed of parts ſo ſtrong as the others, which generally are the firſt, burſt and ſtrengthen the reſt; by which means, as thereby the internal heat is better retained in the fermenting liquor, the fermentation is capable of being carried to a farther degree of perfection; its particles now become more poignant and powerful, its volatile ones fly off, the laws of motion begin to take place, the heavy parts ſubſide, the lighter aſcend in right lines, and the rocky head, which before covered it, becomes uniform again, but of a

greater volume. The Wine, by being more attenuated, is at laſt unable to ſupport, on its ſurface, the weight of ſuch a quantity of froth, rendered ſtill more denſe by repeated exploſions; for which reaſon the liquor, leſt it ſhould be fouled by the falling in of the froth, ought, at this juncture, to be put into veſſels, or caſks, having only a ſmall aperture. In this ſtate it will continue to ferment, with a ſlower, and leſs perceptible motion, even when the bung-hole of the caſk is ſtopped, ſhould it, by any other means, gain the leaſt quantity of external air; and if the Muſt was perfectly ſaponaceous, it will continue to ferment until it becomes fine and pellucid.

It

It is eaſily conceived from hence, That a cold air, cloſing the pores of the liquor, muſt retard the act of fermentation, as heat forwards it:

That Muſts charged with oils ferment with more difficulty, and require a longer time before they become perfectly ſaponaceous and fine:

That Muſts charged with ſtill larger quantities of oil, ſo as to exceed the power of their own acids, and of thoſe that are abſorbed in fermenting, require a ſtill longer time before they can become pellucid, unleſs aſſiſted by precipitation: and that there may be caſes, where even precipitation cannot fine them.

This naturally leads us to another diviſion of Wines; into ſuch as ſoon grow fine, and ſoon become acid, being the growth of cold countries:

Such as by a due proportion of heat, both when the Grapes germinate, and when they come to maturity, form a perfect ſaponaceous Muſt, which will not only preſerve itſelf, but, in due time, become fine;

And ſuch, as, having taken their firſt form under the higheſt degrees of germination (as I termed them) being more replete with oils, diſappoint the cooper, and render the application of menſtruums uſeleſs, unleſs in ſuch quantities as to change the

the very nature of the Wine. Proofs of what I have here aſſerted, may eaſily be collected from conſidering the Wines made in *England*, in *France*, in *Portugal*, or *Spain*, at the *Madeira's*; and ſuch as come from the *Indies*, which are never bright.

The great difference then in Wines ariſes from the climate; and a ſimilar difference in Beers ariſes from the different degrees of heat the Malt has been expoſed to in drying, or extracting.

Fermentation continues in a Muſt which is perfectly ſaponaceous, even after its firſt proceſs of becoming fine; for every fretting is a continuance of fermenta-

tion, though often almoſt imperceptible; the oils become more attenuated, and leſs capable of retaining the elaſtic air: this is often the caſe after the liquor is pellucid; ſo that it is impoſſible to determine, by any rule, the exact ſtate in which Wines ſhould be, in order to be perfect for uſe. Both Wines and Beers, when new, poſſeſs more elaſtic air, than when meliorated by age; how this muſt affect the human body, the phyſical Gentlemen beſt know: deciſions of this ſort exceed the Brewer's province, which ſeems confined within the bounds of taſte, which chiefly depends on the palate: however, thus much may we venture to ſay for Wines, or any fermented liquors, To be wholeſome, they muſt be poſſeſſed of the whole

of

of their fermentable principles: for which reaſon Beers or Ales, when ſubſtituted for Wines in common, but more eſpecially when given to the ſick, ſhould always be brewed from entire Malt: for the laſt extracts, poſſeſſing but the inferior virtues of the grain, have by ſo much leſs the power to become light, ſpirituous, and tranſparent; and that every kind of fermented drink abſolutely ought to be ſo, Nature herſelf points out to us.

It ſometimes happens, that tho' the Muſt is greatly overloaded with oils, yet there is a greater tendency to fermentation than to putrefaction. In this caſe, time will get the better of the diſeaſe. This ſometimes happens (though in a leſſer degree) in Wines of the growth of a too hot ſun;

ſun; they are, for ſome time, faint and ſick, but often recover by heat: more frequently is this the caſe in Beers extracted by too hot a liquor, or overcharged with Hops: theſe, at a certain period, ſicken, ſmell rancid and diſagreeable, but, by long ſtanding, they firſt fret, and then receiving more acids from the air, recover their former health and taſte.

If the fermentation ſtill continues, the liquor becomes acid; moſt of the oils of the Muſt, and moſt of its elaſtic parts having ſpent themſelves, and their places being ſupplied by acids from the air: in this ſtate it is Vinegar.

Its laſt ſtage, or termination, is when, the remaining active princi-

ples

ples the Vinegar poſſeſſed, being abſorbed in air, a pellicle forms itſelf on the ſurface of the liquor, and duſt and ſeeds, which always float in the medium, depoſiting themſelves thereon, ſtrengthen this film into a cruſt, on which grow moſs, and many other vegetables, which, together with the Air, exhauſt the watery parts, no ſign of fermentable principles remain; and, like the reſt of created beings, all its virtues being loſt, what is left obvious to our ſenſes, is a ſubſtance reſembling common earth.

Upon the whole, then, it appears, that a liquor fit for fermentation muſt be compoſed of water, acids ſmoothed over with oils, or ſaccharine ſalts, and a certain portion of elaſtic

claſtic air; that the heat of the air the liquor is fermented in, muſt be in proportion to the denſity of its oils, that the pores may be expanded by ſlow degrees, leſt the air, by being admitted too haſtily, or quick, ſhould cauſe an efferveſcence rather than a fermentation, and turn the whole acid. For theſe reaſons, Wines fermented in countries where the autumn is hot, require their oils to be more pinguious than where the ſeaſon is cooler. For the ſame reaſon, Beers are beſt made when the air is at forty degrees of heat, or below the firſt fermentable point, becauſe then the Brewer can put his Wort to work at a heat of his own chuſing, which will not be augmented by that of the air; but, on the contrary, when by its internal motion

tion its heat is encreaſed, it will again be abated and regulated by the cold of the medium.

The acids in the air are blunted by the oils in the Muſt, conſequently when the acids are conveyed in a greater proportion into the Muſts, the Muſt ought to be charged with a greater proportion of oils; for this reaſon, ſmall beer brewed in ſummer, when the air and the acids more eaſily inſinuate themſelves into the liquor, ought to be enriched with oils by hotter extracts; and in winter the contrary method muſt be purſued.

Wines are ſometimes vapid and flat, but not ſour; this does not ariſe from their imbibing the air, but from their fermenting and generating too much

much air; for which reaſon they are beſt preſerved in cool cellars, whereby their active, invigorating principles are kept within due bounds, and not ſuffered to fly off.

Muſts overcharged with oils, inſtead of fermenting, putrefy, even though, by means of yeaſt, elaſtic air has been conveyed into them. The over-proportion of oil, and its tenacity, prevent the entrance of the acids, the Muſt cannot receive any enlivening principle from without, and the air the yeaſt conveyed into it, is enveloped with oils ſo tenacious as to be incapable of action; for nothing ſo much accelerates putrefaction as heat, moiſture, and ſtagnating air; and all ſubſtances corrupt, ſooner or later, in proportion to

to their mixture with air, to the vent they have, and the closeness of their confinement.

Ferments in general, such as yeast, flowers or lees of wine, honey, the expressed juices of ripe fruit, are only subjects more or less replete with elastic air, conveying the same to the Musts that stand in need of it. As these are liable to be tainted externally by corruption, and internally with regard to the nature and contents of the elastic air, great care ought to be taken in the choice of them. *Boerhaave* has ranged these, and several other, in different classes, in proportion to their fermentable powers, or rather in proportion to the quantity of air they contain for this purpose. Every imperfection in the ferment

ferment is ſo readily communicated to the Muſt, that it would not be an improper queſtion to be determined by phyſicians in a time of ſickneſs, whether the uſe of thoſe which have been made in infected places ought to be permitted; and whether, at all times, drink fermented in a pure and wholeſome air is not preferable to that which is made among fogs, ſmoke, and nauſeous ſtenches *.

* By Dr. HALES's experiments made for diſcovering the proportion of Air generated from different bodies, it appears, that Raiſin Wine in fermenting abſorbed a quantity of Air equal to nearly one third part of its ſubſtance; and Ale, under the like circumſtances, abſorbed one fifth.

SECTION

SECTION VIII.

Some farther Thoughts on FERMENTATION.

IN the foregoing ſection I have endeavoured to relate the proceſs of Fermentation, as it ariſes from Muſts that are moſt perfect for this act, and whoſe Wines, to become light and pellucid, require time only, and no additament. Nor have I deviated from this plan, except as I found opportunity to apply its principles to the Brewery: but as, in the art of Brewing, there is no part ſo difficult, and at the ſame time ſo important to be underſtood, as the cauſe and effects of Fermen-

tation; ſo an examination of this act, in all the different lights in which it offers itſelf to our notice, muſt be thought intereſting.

The Muſts of Grapes, when fermented, form more Lees than thoſe from Malt do; and thus this ſhews, that they poſſeſs their elaſtic Air in a greater number of much ſtronger, though ſmaller, veſſels; which, in general, would be an argument of their being capable of preſerving themſelves longer in a ſound ſtate; for the more powerfully Air is enveloped in the Muſt, the more frettings, and the greater attenuation of the Oils does the Wine require before the Air can be abſorbed. Now, this great quantity of elaſtic Air reſided originally in the fruit; whereas

whereas Malt, by the Barley being firſt ſaturated with Water, and then dried, hath its Air, in part, driven out; for the heat which performs the operation of Malting, much exceeds the limits of Fermentation; and the expulſion of Air from the Worts of Beers and Ales is ſtill further effected by the extracts from Malts undergoing a long boiling, which occaſions the neceſſity of replacing their elaſtic Air by the addition of Yeaſt, in order to their becoming fermentable: in which proceſs, when duly carried on, the Muſts of Malt produce, generally, two gallons of Yeaſt from one quarter of the grain; whereas, in the coldeſt fermenting weather, one gallon of Yeaſt is ſufficient to work that quantity. Much elaſtic Air ſtill

remains in Beer, or Wine from Corn, after the firſt act of Fermentation is over, and the liquor is ſeparated from the Yeaſt above-mentioned, as it is then neither flat, vapid, nor ſour: ſo that if we ſay, Malts, by their being dried, and having their extracts boiled, loſe only one part in three of their Air, we ſhall, perhaps, not be very far from the truth. But as the loſt Air, juſt mentioned, is replaced only by Yeaſt, it muſt be obſerved, that Yeaſt, or the flowers of Malt liquor, are of a weaker texture than thoſe of Grapes; and conſequently the elaſtic Air in the bubbles not ſo much compreſſed. This ariſes from their Oils being leſs tenacious, from their firſt Fermentation being performed in a much ſhorter time, and from the greater heat

heat of the Fermentation which produced the flowers: they are alſo more equal in ſize. From theſe cauſes their effect is more ſpeedy; inſomuch that were the Air-bubbles produced from Malt, and applied to a Muſt, to be equal in number to thoſe in the ſame quantity of unfermented juice of Grapes, their quick exploſion would cauſe an Efferveſcence, and not a Fermentation; by which means the liquor would ſoon ſicken, and be void of every enlivening principle: for this reaſon all artificial Fermentations ſhould be carried on in the ſloweſt and cooleſt manner poſſible, eſpecially where drinks are intended for keeping; and for the like reaſons they will not bear to be ſo often drawn off, or deprived of their lees, as natural Wines; in my opinion this

ought not to be done at all, unleſs, for ſome defect, they are to be blended with freſh Worts under a freſh Fermentation.

The different Fermentations may be ſaid to be, at leaſt, as various as the ſeveral ſpaces of time, which Wines formed from Grapes, or any other vegetable, require, before they come to the proper degree of perfection for uſe: the enumeration of them is as endleſs as unneceſſary; but, to come nearer to our purpoſe, Fermentation may be divided, not improperly, into Natural and Artificial: the firſt is, when it riſes ſpontaneouſly, ſo as to anſwer all the neceſſary purpoſes; and the other, when it is aſſiſted by what we gene-

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rally term Ferments, or the ſubſtitutes requiſite to excite the act *.

* This diviſion I chuſe, as moſt convenient to my preſent purpoſe; for undoubtedly there are liquors, which tho' they have of themſelves the fermentative properties, and naturally performed the act, yet, either thro' want of tranſparency, or of ſuch properties as would enable the Wine to maintain itſelf in a ſound ſtate, ſo as to be meliorated by time, are more defective than ſuch as are made to perform the act by ſubſtituted Ferments: and ſome artificial Fermentations there are, in which Ferments are ſo duly adminiſtered, that, in the end, they approach very near, and even vie with the moſt perfect natural Fermentation. Were I to enter into a more minute detail, it might be ſhewn, that Wines, when tranſported from a hot climate to a cold one, are often thereby ſo impeded in this act, as, from thence, to become imperfect; and that Beers removed from this to a more ſouthern region, are often improved, and ſooner brought to be fit for uſe; but though canvaſſing ſuch ideas might enlarge and improve our conceptions of this act, to indulge them, at pre ent, would exceed the bounds and deſign of this Eſſay.

All vegetable ſubſtances poſſeſs fermentable principles, though in a diverſity of proportions; but thoſe juices only which are of ſuch a nature as to arrive at ſome degree of perfection in proportion to the quantity of their fermentable principles, can be made into Wines. I would not, from what I have before ſaid, be underſtood, as if vegetables were more or leſs acid, or more or leſs ſulphureous, from the heat of the climate they grow in. This, though one of the reaſons of their being ſo, is not the only one; the form, make, and conſtitution of the plant is another; for in very hot climates are produced acid fruits, ſuch as Limes, Tamarinds, Lemons, and Oranges, whoſe fermentable properties are ſuch, as to be very far from making

making ſound Wines, though, in ſome degree, they may be ſuſceptible of Fermentation; and even in thoſe countries, ſo greatly favoured by the ſun, they have Vines of ſuch a nature, as to attract the acids from the Air and Earth ſo greedily, that, when their juices are fermented, they ſoon become ſour: and, on the contrary, in cold climates we ſee warm aromatic vegetables grow, ſuch as Hops, Horſeradiſh, Camomile, Wormwood, *&c.* whoſe fermentable principles are ſuch, that not without difficulty, perhaps not perceptibly, would they ferment. Theſe inſtances are to be accounted as extremes; for in cold countries, equally as in hot, fruits are produced ſuſceptible of a perfect fermentation, as Apples, ſome ſpecies of which are

endued

endued with ſuch auſtere and aromatic qualities, that their expreſſed juices are capable of ſpontaneouſly fermenting until they become pellucid, and capable of remaining in a ſound ſtate many years. From hence it appears, that proper ſubjects, which will naturally ferment for making Wines, may be found in almoſt every climate. *England*, ſays *Boerhaave*, is, on this account, remarkably happy: her fruits are capable of producing a great variety of Wines, equal in goodneſs to many imported, were not our taſtes, perhaps, made ſubſervient to our prejudices.

The effect of the act of Fermentation on liquors, is ſo to attenuate the oils of vegetables, as to cauſe them

them to become ſpirituous, and eaſily inflammable. When a Wine is diſpoſſeſſed of ſuch Oils, as is nearly the caſe in Vinegar, far from poſſeſſing a heating or inebriating quality, it becomes a remedy againſt intoxication, and refreſhes. Thus the term of Fermentation ſhonld be applied only to that act which occaſions the expreſſed juices of vegetables to become Wine: but as ſeveral acts paſs under the name of Fermentation, it may not be improper to diſtinguiſh them here according to theſe principles.

Vegetation, one of them, is the act wherein more Air is attracted, than is repelled. I believe all that hath been ſaid above concerning the juices of Grapes, is a convincing proof thereof.

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Fermentation is where the communication of the external and internal Air of a Muſt is open; and, when in its perfect ſtate, the power of repelling is equal to that of attracting Air.

Putrefaction is when, by the power of ſtrong Oils, or otherwiſe, the communication between the external and internal Air is cut off, ſo that the liquor neither repels nor attracts, but, by an inteſtine motion, the united particles ſeparate, and tend to fly off.

Effervescence is when, by the power of attraction, the particles of matter ſo haſtily ruſh into contact, as to generate a heat which expels the incloſed Air; and this, more or leſs,

leſs, in proportion to the motion excited.

Hitherto I have conſidered Grapes as a moiſt pulpous fruit, ſufficient of themſelves to furniſh Water for extracting their other parts; but the natives of the countries where this fruit abounds, in order to preſerve them, as near as poſſible, in their primitive ſtate, ſuſpend them in the ſun, or place them in ovens, to dry; by which means being, in a great meaſure, diveſted of their watery particles, they remain almoſt inactive, without juices ſufficient to form Wine, unleſs Water be added to them; which element becoming, in that caſe, a ſubſtitute, might, from thence, be ſaid to be a ferment, and con-

conſequently this might be accounted the firſt claſs of artificial Wines.

In all bodies, from the various proportions of their conſtituent parts ariſe different effects: thus, from hence, they are, more or leſs, in a durable ſtate, and accordingly tends either to Inaction, Fermentation, or Putrefaction. Now, by a judicious ſubſtitution of ſuch parts as ſhall be wanting to bodies, they may be reſtored to their priſtine nature; as may be plainly proved by the obſervations and experiments communicated to the public by Dr. *Pringle*. Thus Grapes, though dried and exported from their natural climate to another, by the addition only of Water, ferment ſpontaneouſly, and form Wines, very near alike to ſuch as they

they would have produced before; and it may with confidence be ſaid, that when any viſible difference appears therein, it ariſes from the injudicious manner in which the water is adminiſtered, from the fruits not being duly macerated, or from want of ſuch heat being conveyed to the water and fruit, as the juices would have had, had they been expreſſed out of the Grapes when juſt gathered; often from the whimſical mixture of other bodies therewith; and perhaps from the quantity of bad Brandy, which is always put to Wines abroad, to prevent their fretting when put on board ſhip: ſo that, upon the whole, tho' ſome ſmall difference is often obſerved, it doth not make void the fact, that a due quantity of water being applied to dry Raiſins, an extract

tract may be formed, which will be impregnated with all the neceſſary conſtituent parts the Grapes had in them when ripe upon the Vine, and will conſequently ferment ſpontaneouſly, and make a vinous liquor.

Vegetables in their original ſtate are diviſible into the pulpous and farinaceous kinds, both poſſeſſing the ſame conſtituent parts, tho' in different proportions. Now, if from the farinaceous ſuch parts be taken away as they ſuperabound in, and others be added in which they are defective, theſe vegetables may, by ſuch means, be brought to reſemble, in the proportion of their parts, more eſpecially in their Muſts, the natural Wines I have before been treating of;

of; which being univerſally acknowledged to be the ſtandard for Wines, the nearer any fermented liquor approaches thereto, by its ſaponaceouſneſs, lightneſs, tranſparency, and taſte, the greater muſt its perfection be.

To enquire which of the pulpous, or which of the farinaceous kinds of vegetables are fitteſt for the purpoſe of Wine-making, would be but an unneceſſary digreſſion. Experience, the beſt of guides, hath, on one ſide, given the preference to the Vine, and on the other to Barley. To make a vinous liquor from Barley, having all the properties of that produced from the Grape, is a taſk which can only be compaſſed by making uſe of ſuch methods, that the Wort of theſe ſhall reſemble the Muſt produced from the

other; for whatever different means have been practiſed to flatter particular palates, to heighten the pungency, or encreaſe the ſtrength, of Beers and Ales, the ſucceſs has but rarely anſwered the intent; as the more complicated a proceſs is, the more it is liable to be erroneous: and this the legiſlative power hath wiſely diſcountenanced, ſeeing the grain brought to a fermented ſtate, but more eſpecially when Hops are added thereto, is ſufficient to anſwer every uſeful and neceſſary purpoſe as a vinous liquor.

Ales, by ſome, are taxed with being viſcid; and Beers have been ſaid to contain igneous particles. The moſt certain marks of wholeſomeneſs in Wines, are tranſparency and light-

lightneſs; yet ſome, which are rich, more eſpecially Malt liquors, though perfectly fine, have been ſaid to be viſcid: tranſparency appears, in many Wines, before the Oils are attenuated to their higheſt perfection, as we have before remarked; where the powers of the Oils and Salts are equal, which is denoted by the brightneſs of the liquor, viſcidity can ariſe only from the want of age: in this caſe it is not a defect, but a miſapplication of the liquor, by uſing it too ſoon.

As to Malt liquors retaining igneous or fiery particles, Malts dried to keep have undoubtedly their particles removed, by Fire, beyond their ſphere of attraction, elſe they would

not be in a fit ſtate to preſerve themſelves ſound; for which reaſon, when they firſt come into contact with the Water which is to extract them, they cauſe an effervescent heat, which only adds to the extracting power, and ſhould be looked on, by the Brewer, as an auxiliary help; but that Fire ſhould be retained either in the Malt or the Muſt, is impoſſible. Fire itſelf is of ſo ſubtile a nature, that its particles, when contained in a body, continually tend to fly off, and mix with the ſurrounding Air; ſo that only an equal degree, with what is in the atmoſphere, can be continued in the grain, or any liquor whatever, after it has been, for ſome time, expoſed therein. Brown Beers, which are made from Malts more dried

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than any other, are, from experience, found to be leſs heating than the liquors brew'd from pale Malt; which probably ariſes from hence, that brown Beers contain a leſs quantity of elaſtic Air than pale Beers, as pale Malt liquors contain leſs than Wines produced from vegetables in their natural ſtate; and not only ſo, but as Malt liquors contain their elaſtic Air in bubbles of a weaker conſiſtency than thoſe made from the juices of Grapes, the effect of Malt liquor, when taken in an over-abundant quantity, is neither of ſo long a continuance, nor ſo powerful, as that of Wine, ſuppoſing the quality and quantity of each to be equal. Tho' to ſome it may appear the effect of prejudice, yet it is but juſtice to the

produce of my country, to add, that ſome Phyſicians have given it as their opinion, that ſtrong drinks from Malt are leſs pernicious than thoſe produced from Grapes. So much, I hope, I may ſay, without being thought guilty either of aſſuming too much, or of countenancing debauch, by pointing out the Wines that occaſion the feweſt diſorders.

SECTION

SECTION IX.

Of the Nature of BARLEY.

BARLEY is a ſpicated, oblong, ventricoſe ſeed, pointed at each end, and marked with a longitudinal furrow. The eſſential conſtitution of the parts in all plants, ſays Dr. *Grew*, is the ſame: thus this ſeed, like plants which have lobes, is furniſhed with radical veſſels, which, having a correſpondence with the whole body of the Corn, are always ready, when moiſtened, to adminiſter ſupport to the plume of the embrio, or what is uſually called the acroſpire. Theſe radical veſſels, at firſt, receive ſuch nouriſhment from

a great number of glandules diſperſed almoſt every where in the grain, whoſe pulpous parts ſtrain and refine ſuch food almoſt to a vapour, and ſo fit it to enter the capillary veſſels; and ſuch an abundant proviſion is made for this nouriſhing of the plume, that the ſame author ſays, theſe glandules take up more than nine tenths of the ſeed.

It is ſown about *March*, ſooner or later, according to the ſoil that is to receive it, and generally reaped in ten or twenty weeks time: moſt plants, which ſo haſtily perform the office of vegetation, are remarkable for having their veſſels proportionably larger; and that theſe may be thus formed, the ſeed muſt contain a greater quantity of tenacious Oils,

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in proportion, than thoſe ſeeds, whoſe veſſels being ſmaller, require more time to perform their growth, and come to maturity. Barley alſo, as may be obſerved, grows and ripens with the lower degrees of natural heat; from whence, and from the largeneſs of the ſize of its abſorbent veſſels, it muſt receive a large portion of acid parts. Thus is it ſaid to be viſcid, though, at the ſame time, a great cooler, Water boiled with it being often drank as ſuch; it is certain, that however it be prepared, it never heats the body when unfermented.

From theſe circumſtances of its being viſcous and replete with acids, it would, at firſt, appear to be a moſt unfit vegetable, from which vinous liquors,

liquors, to be long kept, ſhould be made; and indeed the extracts made from it in its original ſtate are not only clammy, but ſoon become ſour.

In its ſtate of full maturity its conſtituent parts ſeem to be differently diſpoſed, than when in a ſtate of vegetation; for then the oils or balſams, which ſheath its turgid veſſels, are lodged in order in their cells, which when it vegetates by abounding with acids, theſe oils readily become fitted to enter and ſwell its radical and capillary parts. By germination alone all its principles are put in action; the fibrous parts, which are not diſſoluble in Water, poſſeſs themſelves of a great quantity of tenacious oils, leaving the glandules and finer veſſels replete with water, ſalts, and the

the pureſt ſulphur. If, in this ſtate, the Corn is placed in ſuch a ſituation, that, by heat, the acid and watery parts may be evaporated, the more ſuch heat is ſuffered to affect it, the the more dry, and leſs acid will the Corn become, and its parts being divided by germination and heat, its viſcidity will be removed; its taſte will become ſaccharine by the acids being leſſened in proportion to the Oils, and theſe be more tenacious, as they have received more heat. This proceſs, regularly carried on, is what is termed *Malting*, which I ſhall endeavour to explain more at large.

But, before we enter thereon, it will be neceſſary to conſider the ſtate of the grain as it comes from the field.

field. When reaped, though, upon the whole, it may be ſaid to be ripe, yet every individual part, or every Corn cannot be ſo: and this, in ſome ſeaſons, is ſo remarkable as to be diſtinguiſhed by the eye. The different ſituations, the winds that have reigned, the ſhelter ſome parts of the field have had from ſuch winds, the weather, and difference in the ſoil, account for this. However, when the greater part of the Corn is ſuppoſed to have come to maturity, it is cut and ſtack'd; the ripeſt parts having the leaſt moiſture, and the feweſt acids; and the greeneſt the greater ſhare of theſe. In this ſtate the unripe part of the Corn, whoſe acids attract, and are greedy of water, communicate their moiſture to ſuch as are more dry, which acting on their Oils,

Oils, an agitation enſues from hence, more or leſs gentle, in proportion to the power of the acids and water; and from this motion ariſes a heat proportioned to the action; ſo that there is no determining the exact degree ſuch heat will ariſe to. When this ſweating in the Mow is kept within its due limits, the whole body of the Corn, after the ferment is over, becomes of one equable dryneſs, and is not thereby diſcoloured; but if put together too wet or green, the heat thereby occaſioned will deſtroy the very power of germination, as the Farmer, to his loſs, will experience; for by encreaſing, and from want of Air recoiling repeatedly, it will blacken, or rather charrs the grain, and often burſt out into actual flame.

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The effect a moderate and gentle ferment of this ſort muſt have on the Corn is that of preſſing its Oils towards the external parts of its veſſels and ſkin; by this means it comes into a ſtate more capable of preſerving itſelf againſt the injuries of the weather; and the more it is in this ſtate, the more backward will it be to germinate when uſed for that purpoſe; if carried too far, as we have before ſeen, by ſuch heat the plume and root of the incloſed embryo muſt be quite ſcorched, and thus the Corn will become inert, and incapable of vegetation. What degree of heat will produce this effect, I will not immediately determine, but apprehend it to be when the particles of the grain are removed from each other beyond their ſphere of attraction;

tion; which experiments on Barley ſhew to be at about 120 degrees.

Vegetables, in general, may be ſaid to be ſuſceptible of a large latitude in this reſpect, according to their different textures; ſo that this degree of heat may, perhaps, be applicable only to Barley, as the ſeeds of ſome Grapes bear 124 degrees of heat, and may be capable of being impreſſed with more, and yet vegetate: but ſurely, if the Oils of the Corn be made ſo tenacious as thereby to be diſcoloured, the ſeed can ſcarcely be revived; and this happens to ſeeds, ſooner or later, by heat, in proportion to the coheſion of their parts, and their weight. But this is a point more properly to be judged of

of by the colour of the grain, and is more immediately the buſineſs of the Farmer and Maltſter, than of the Brewer.

Thus, though it may be diſadvantageous to the Maltſter to ſteep grain, which has not ſweated in the Mow, as, from hence, it will not equally imbibe the Water; ſo Barley that is over-heated, or *Mow-burnt*, is not fit for his purpoſe; and it is ſcarcely poſſible any large quantity of Barley, from the ſtack, ſhould equally make perfect Malt, as the heat, generated on its being thus put together, is always greateſt in the centre of the Rick, and conſiderably more ſo than in its exteriour parts.

MALT-

MALTING.

This proceſs begins with the proper means for ſetting the conſtituent principles of the grain in motion; ſo that the Oils, which before ſerved to defend the ſeveral parts, may be enabled to take their proper ſtations. This is effected by ſteeping the Barley in Water, where it ſtrongly attracts moiſture, as all dry bodies do; but it requires ſome time before the grain is fully ſaturated therewith, as two or three days, more or leſs, in proportion to the heat of the Air: for vegetables receive the water only by its ſtraining through the outward ſkin and abſorbent veſſels, whoſe texture, though dry at firſt, yet hath its pores ſo very fine, that they require

this element to be reduced almoſt to a vapour, ere it can gain admittance; and heat hath not only the property of expanding ſuch pores, but, perhaps, that alſo of rendering Water more fit to make its way into them.

When the Barley is fully ſaturated, though a great quantity of Air is expelled from it, as appears from the number of bubbles which ariſe on the ſurface of the water, yet ſtill much remains in the Corn. A judgment is formed of the criſis, when it can imbibe no more of the watery element, from its turgidity and pulpouſneſs, which occaſion it eaſily to give way to an iron rod dropped perpendicularly into it. Then is the Water let go, or drawn off, the grain is taken

taken out of the ciſtern, and laid in a regular heap: here, for the ſame reaſons as Hay, or any other moiſt vegetable, when ſtacked together, grows hot, ſo doth this heap of Barley. The Air compreſſed in its glandular parts and veſſels by moiſture, and warmed by the inteſtine motion, expands, and with this force expels their Oils from the capillary veſſels into the roots, in order to fill, extend, and diſpoſe them to ſeek and receive nouriſhment for the embryo or acroſpire, which while the root is procuring, the plume is ſoftened with moiſture from the glandular parts. The root, having received ſome power (before it expands its fibres) by its heated elaſtic Air, preſſes the Oils into the acroſpire, which are replaced by the ſeminal veſſels furniſhing all

they are able into the roots to forward the action. But that the Corn in the heap may not acquire too great a degree of heat, and carry on the germination too faſt (by which means the finer parts, with which the cellules are replete, would not only be waſted, but be ſo heated as to intangle with them the coarſer Oils of the grain, which would occaſion the Malt, when made, to be bitter, and ill taſted) it is then, at a due temperature, diſperſed in beds on the floor of the Malt-houſe, and gradually ſpread thinner and thinner, being frequently turned, from time to time, in proportion as it is, more or leſs, ſlow in growth, ſo that it may come tolerably dry to the kiln, in ſuch a ſtate that its fibrous roots ſhall be ſpread, and the ſpire be near coming

coming thro' the ſkin of the Barley; by which the Maltſter is ſatisfied, that every part of the grain has been put in motion, and ſeparated. But juſt ſo much of the parent-ſeed will become ſaccharine Salts, or Malt, as where the upper part of the plume reached in this proceſs. The Corn, thus prepared for being dried, is, in this lively and active condition, ſpread on the kiln; where meeting with a heat ſuperiour to that requiſite for gradual vegetation, its farther growth is ſtopped; though, in all probability, from the ſoftneſs of the firſt heat 'tis impreſſed with, none of the finer veſſels are, by this ſudden change, rent and torn, but, by drying, are ſhrivelled and rendered inactive, and put in a preſervative ſtate. Now, let it be obſerved, that thoſe Oils

which formed the roots, being thus puſhed out of the body of the grain, and dried by heat, are loſt to any future wort, as they are to be ſcreened off, ſeeing they are not ſoluble in water; which is likewiſe true of thoſe parts which compoſe the ſhoot or plume: ſo that the internal parts of the Malt have remaining in them a greater proportion of Salts to the Oils than before, and conſequently are become leſs viſcid, more ſaponaceous, and more eaſy to be extracted.

In this proceſs the acid parts of the grain, though they are the moſt ponderous, yet being very attractive of water, which occaſions them to become weaker, are, by the continued heat of the kiln, volatilized, and

and evaporate, with the aqueous ſteam from the Malt; while, at the ſame time, the Oils become of a greater ſpiſſitude, and of a larger capacity in their pores. Thus, by Malting, the grain hath fewer acids in proportion to its Oils; and, at the different ſtages of dryneſs, obtains different properties; in the firſt ſtage reſembling the fruits ripened by a weaker ſun, and, in the laſt, exceeding the growth of the hotteſt climate.

Malt, whoſe colour is not altered by heat, is termed Pale Malt, from its retaining its natural whiteneſs; but when the fire on the kiln is excited with more vehemence, and kept up a longer time, it affects both the Salts and the Oils of the grain, in

proportion to the degree of heat, and to the time, and thus occaſions it to differ in colour: for Fire, (ſays Sir *Iſaac Newton)* and that more ſubtile diſſolvent, putrefaction, by dividing the particles of ſubſtances, turn them black; an exceſs, which ſeldom is, and ought never to be the caſe with Malt. From the colour, with which Fire hath imprinted them, Malts receive their ſeveral denominations.

The condition the Barley was gathered in, whether green or ripe, is alſo clearly diſcernible when it is malted. If gathered green, it rather loſes than gains in quantity; for almoſt its whole ſtock of Oil being expended in germination, the Malt becomes of a ſmaller body, ſhrivelled, and

and often unkindly; while that which hath come to full maturity increaſes by Malting, and if properly carried thro' this proceſs, is plump, bright, and clean, and, on being cracked, readily yields fine mealy parts, ſo much deſired by the Brewer.

The Malts, when dried to the pitch intended by the maker, are removed from the kiln into a heap. There their heat gradually diminiſhes, and, from the known principles of fire, flies off, and diſperſes itſelf in the ambient Air, ſooner or later, as the heap is, more or leſs, voluminous; perhaps too in ſome proportion to the weight of the Malt, and as the fire has cauſed it to be, more leſs, tenacious in its parts. Nor can it be ſuppoſed, that any of its parts

parts can ſo retain fire, as not to ſuffer it to fly off, much leſs keep that element in a ſtate of inactivity, and imperceptible to our ſenſes. Bars of iron or braſs, even of a conſiderable ſize, when heated red-hot, cool and loſe their fire, though their texture is, undoubtedly, much cloſer than that of Malt or Barley, and the experiments made by Dr. *Martin*, on bodies heating and cooling, corroborate this fact: concerning which I have been more particular than ſeemingly it ſhould require, on account of the ideas that have been formed from the technical phraſe uſed by Brewers, when they ſay, Malts are full of fire, or want fire; from whence a prejudice hath been conceived, by ſome, againſt drinks made from brown Malt, though they have been many months

months off the kiln, and have no more heat in them, either whole or ground, than the ambient Air they are kept in. The truth of the matter is, that in proportion as Malts are more or leſs dried, ſo are their particles ſeparated from one another beyond their ſphere of attraction, and coming in contact with another body, ſuch as Water, ſtrongly attract from it the uniting particles they want. The more violent this inteſtine motion is, the greater is the heat generated juſt at, and only for, that time; but the effect of this ſlight efferveſcence having been taken notice of before, it is needleſs to repeat what hath been ſaid.

The minute circumſtances of the proceſs of Malting will be more readily

dily conceived from what will hereafter be ſaid thereon. The effects that fire will have, at ſeveral determinate degrees, on what, from Barley, may be now termed *Malt*, is an object that moſt particularly concerns the Brewer; and that they are various, both as to the colour and properties of the Malt, is certain; for it appears, ſays *Boerhaave*, from chemical obſervation, that a determinate degree of heat produces, on every body, a certain effect; and hence, as the action of it grows ſtronger or weaker, the effect will be different from what it was before.

SECTION.

SECTION X.

Some farther Conſiderations on MALTING.

BARLEYS, by Malting, may, at a medium, be ſaid to loſe one fourth part of their weight, including what is loſt by the roots being ſcreened off; though this proportion varies, according as they are, more or leſs, dried.

As the acroſpire, and the outward and inward ſkins of the grain are not diſſoluble in Water, the glandular or mealy ſubſtance, the only part which gives any virtue to the liquor, is certainly very ſmall in quan-

quantity, and of little weight. But as this alone poſſeſſes the fermentable principles of the grain, every different circumſtance heat can place it in, requires our utmoſt attention.

We have before ſeen, that Wines, Beer, and Ale, after their firſt Fermentation, are meliorated only by age, through the more refined and gentle emotions they undergo, which often are not perceptible to our ſenſes. To gain this favourable effect we muſt form Worts, which are capable of maintaining themſelves, for ſome time, in a ſound ſtate. This quality, if not originally in the Malt, is not to be expected in the liquor. But as ſome objections have been raiſed againſt this method of arguing, and theſe aided by prejudice, often

often more powerful than the objections themſelves, it is neceſſary, as far as the making a proper Wort is concerned, to reaſſume the conſideration of the Grain, as it comes from the Mow, and trace it to the Kiln, where the Fire may alter or deſtroy its properties.

Barley in the Mow, tho' it ſcarcely undergoes a heat there much greater than 100 degrees, yet may be extracted or brewed without Malting. This the Diſtiller's daily practice evinces; but then he commits ſuch extracts to the Still immediately after the firſt Fermentation, elſe they would not remain long in a ſound ſtate; nor is this method practicable, even by him, in ſummer-time, as the very extracts would then turn

ſour

ſour before they were ſufficiently cooled to ferment. By this means all the charge of the Malt-duty is ſaved; but our ſpirits are thereby made greatly inferiour to thoſe of the *French*. *Boerhaave* recommends their method, which is, to let the Wines ferment, ſubſide, and be drawn off fine from the lees, before they are diſtilled: but this can be done only with Wines from malted grain, and if practiſed, the difference would ſoon ſhew, how neceſſary and uſeful it is to give Wines (either from the Grape or Corn) time to be ſoftened, before they are uſed for any purpoſe whatever.

But might not Barleys be dried without being germinated? Undoubtedly they might; but as they abound

abound with ſtrong Oils, they would require a more conſiderable heat for this purpoſe, by which the oleaginous parts would be rendered ſo compact as nearly to reſemble the conſiſtence of a Varniſh, ſcarcely to be mollified by the hotteſt Water, rather than a ſubſtance fit for that element to diſſolve.

Barley then, ungerminated, either in its natural ſtate, or when dried, is not fit for the purpoſe of making Wines; but when only germinated, and not dried by Fire, as the coarſer Oils are thereby expelled, and the mealy parts of the grain, by this act alone, become ſaccharine, might not this ſuffice without drying by Fire? Not to dwell on the difficulty of ſtopping germination at the proper degree without Fire, ſo that ſufficient

quantities of grain, thus prepared, ſhould always be provided for the purpoſes of brewing; not to mention the impoſſibility of grinding ſuch grain, as it would then be ſpungy and tough, but having regard ſolely to the purpoſe it is to be applied to, that of forming Beers and Ales capable of preſerving themſelves for ſome time; we ſhould, on this occaſion, find ſo many acids blended with the Water ſtill remaining in the grain, that, in the moſt favourable ſeaſons for brewing, they would render all our endeavours abortive, and in ſummer-time would make it impracticable to brew at all in any manner whatever.

I have heard of a project of germinating grain, and drying it in the hotteſt

hotteſt ſummer's ſun, in order, by this means, to malt it without the expence of fuel: but tho' the hotteſt days in *England* may be thought ſufficient for this act, as well as for making Hay, yet as Barley and Graſs are not of equal denſities, the effect would not be alike. Beſides, as the Grain is to be grown to a certain degree, this very hot ſeaſon, ſo favourable, in appearance, to one part of the proceſs, would be directly contrary to the other; for the Barley, by this heat, would ſhoot, and come forward ſo faſt, as to entangle, too much, the conſtituent principles of the Grain with one another, and drive the coarſer ill-taſted Oils among the finer mealy parts intended to be ſweet; theſe alone, in their utmoſt purity, being the ſubject required for ſuch

as would obtain good Drinks. And here I cannot help obſerving the general diſpoſition of mankind, to wiſh for the gifts of Nature in a different manner than ſhe has vouchſafed to beſtow them. Theſe various ſchemes, if I miſtake not, have ſprung from the deſire of having Beers and Ales white or pale; whereas they muſt naturally be yellow or brown: ſuch ſchemes are but ſo many attempts to force Nature, and the proſecution of them muſt frequently be attended with diſappointments. It is true, that tho' Malts be dried ſlack, yet if they be made in winter, ſpeedily uſed, and brewed in the moſt proper ſeaſon, they may make a tolerable Drink, which may preſerve itſelf, for ſome time, ſound: but as the proportion, which ſhould be kept between the heat which dried the

the Malt, and that which extracts it, cannot, in this caſe, take place, and as the Grain will be more replete with Air, Water, and Acids, than otherwiſe it ſhould be, the Drink, ſuppoſing the moſt fortunate ſucceſs, and that it doth not ſoon turn acid, muſt ſtill be wanting in ſalubrity, by frothing and exploding too much; as an exceſs in any of the fermentable principles is always hurtful.

Barley then, to be made fit for the purpoſe of brewing, muſt be malted; that is, it muſt be made to ſprout or germinate with degrees of heat nearly equal to ſuch as the ſeed ſhould be impreſſed with when ſown in the ground; and then it muſt be dried with a heat ſuperiour to that of vegetation, and capable of checking it.

How far germination ſhould be carried, we have already ſeen; the law here ſeems to be univerſal, as to the extent of the acroſpire: the degree of dryneſs admits of a larger latitude, and to what extent heat may be properly carried ſhall be the ſubject of our next inquiry.

Malt dried in ſo low a degree as that the vegetative power is not thereby deſtroyed, on generating the leaſt heat by lying together in a heap, germinates afreſh, and ſends forth its plumes or acroſpires quite green: the ultimate parts thereof are then within each other's ſphere of attraction, elſe this regermination could not happen; and thus the grain may be ſaid not to be malted, or in a preſervative ſtate. Bodies whoſe par-

particles are removed, by heat, beyond their ſphere of attraction, can no more germinate; but coming in contact with other bodies, as Malt with Water, they efferveſce: and the Grain we are now ſpeaking of, firſt ſhews this act of effervescence, when it has been thoroughly impreſſed with a heat of 120 degrees; and here alſo doth its colour, from a white, begin to incline to a yellow. Such then are Malts ſo cured as to be able to maintain themſelves ſound, yet, for this purpoſe, poſſeſſing as much Air, and as many acid and watery particles as they are capable of; conſequently this may be termed the firſt and loweſt degree of drying this Grain for Malt.

To diſcover the laſt degree this Grain, when germinated, is capable of enduring, we have no circumſtance to direct us, with the ſame certainty that efferveſcence help'd us to the firſt: we muſt therefore have recourſe to that heat which deprives it of its chiefeſt virtue. Now, Dr. *Shaw* ſays, *Alcohol is one of the moſt eſſential parts of Wine*; ſo that, when abſent, the Wine loſes its nature; and when properly uſed, it is a certain remedy for moſt diſeaſes incident to Wines, as keeping them ſound, and free from corruption: whence we have another rule for preſerving vegetable and animal ſubſtances from corruption. Before this he ſays, *No ſubjects but thoſe of the vegetable kingdom are found to produce it.* Is

Alcohol

Alcohol then a new body created by fermentation and diſtillation, or did it originally, tho' latently, reſide in the vegetable? *I have, for a good while, been ſatisfied, by experiments (ſays* Boerhaave) *that all other inflammable bodies are ſo only as they contain Alcohol in them, or, at leaſt, ſomething, that, on account of its fineneſs, is exceedingly like it, the groſſer parts thereof, that are left behind, after the ſeparation of this ſubtil one, being no longer combuſtible.*

The uſe I would make of this is, that, as the ſame author, in his *Elements of Chemiſtry*, vol. I, page 195 to 199, clearly proves by experiments, N° 8, 9, 10, 11, 12, 13, that Fire, by burning combuſtible bodies, as well as by diſtilling them, ſeparates

ſeparates their different inflammable principles, according to their various degrees of ſubtility: hence muſt the Alcohol reſiding in the Barley, when expoſed to ſuch a degree of heat as would cauſe it to boil, *i. e.* 175 degrees, make great efforts to diſengage itſelf from the Grain. From this chain of reaſoning it is natural to conclude, that, in a body like Malt, prepared for fermentation, or the making a vinous liquor, this event muſt take place at the ſame time that the Malt charrs. Now, charring may well be termed the laſt degree of dryneſs, as when it takes place, the volatile parts, and thoſe proper for forming a fermentable Muſt, are diſſipated; nor can any more acids ſubſiſt where the coheſion is deſtroyed: ſo that charring is a criſis in ſolid bodies,

dies, ſomewhat analogous to ebullition in moiſt ones; that is, they are perfectly ſaturated with Fire, but their fixed principles not thereby deſtroyed. From hence, as liquors boil with a greater or leſs heat, in proportion to their tenacity or gravity, ſolid bodies may be ſaid to be charred with ſuch proportions of heat alſo; ſo that the whole body of the Barley cannot, at the ſame inſtant, become black, nor, where any quantities are under the like ſituation, if not equally germinated, can the whole charr with the ſame degree of heat. To the ſeveral reflections before made, if the following experiment be added, I hope it will prove ſatisfactory. And thus having two limited and diſtant degrees, we may thereby determine and fix the properties of the

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intermediate ſpaces, in proportion to their expanſion.

In an earthern pan, of about two foot diameter, and three inches deep, I put as much of the paleſt Malts, very unequally grown, as filled it on a level to the brim. This I placed over a little charcoal lighted in a ſmall ſtove, and kept continually ſtirring it from bottom to top: at firſt it did not feel ſo damp as it did about half an hour after.

In about an hour more it began to look of a bright Orange-colour on the outſide, and appeared more ſwelled than before. Every one is ſenſible how long-continued cuſtom alone makes us ſufficient judges of colours. Then I macerated ſome of

of the Grains, and found they were nearly ſuch as are termed brown Malts. On ſtirring and making a heap of them towards the middle, I placed therein, at about half depth, the bulb of my Thermometer, and found it roſe to 140 degrees: here the Malt felt very damp, and had but little ſmell.

At 165 degrees I examined it in the ſame manner as before, and could perceive no damp; the Malt was very brown, and, on being macerated, ſome few black ſpecks appeared.

Now many corns, neareſt the bottom, were become black and burnt: with all the diligence I could uſe, I placed my thermometer nearly there, and it roſe to 175 degrees; but the par-

particles of Fire ariſing from the ſtove, act on the Thermometer in proportion to the diſtance of the ſituation it is placed in; for which, through the whole experiment, an abatement of 5 degrees ſhould be allowed, as near as I could eſtimate; ſo, a little after, putting my Thermometer in the ſame poſition, where nearly half the corns were black, it ſhewed 180 degrees. I now judged, that the Water was nearly all evaporated, and the heap grew black apace.

Again, in the center of the heap raiſed in the middle of the pan, I found the Thermometer at 180 degrees; the Corn taſted burnt, and the whole, at top, appeared, about one half part, a full brown, the reſt black; on being macerated, ſtill ſome white

white ſpecks appeared, which I obſerved to proceed from thoſe Barley-corns which had not been throughly germinated, and whoſe parts cohering more together, the Fire, at this degree of heat, had not penetrated them; their taſte was inſipid, the Malts brittle, readily parting from the ſkin: but the Thermometer was now more various, as it was nearer to, or farther from, the bottom; and here I judged all the true Malt to be charred.

However, I continued the experiment, and at 190 degrees, ſtill found ſome white ſpecks on macerating the grain: the acroſpire always appearing of a deeper black or brown than the outward ſkin: the Corn now fried at the bottom of the pan.

I next

I next increaſed the Fire; the Thermometer, placed in the mean, between the bottom of the pan, and the upper edge of the Corn, ſhewed 210 degrees, the Malt hiſſed, fried, and ſmoaked abundantly; tho', during the whole proceſs, the grain had been kept ſtirring, yet, on examination, the whole was not equally affected by the Fire. I found a great part thereof reduced to perfect cinders, eaſily crumbling to duſt between the fingers, ſome of a very black hue, without gloſs, ſome very black, with Oil ſhining on the outſide. Upon the whole, two third parts of the Corn was perfectly black, the reſt of a deep brown, more or leſs ſo as they were hard, ſteely, or imperfectly germinated; which was eaſily diſcovered by the length of the

the ſhoot. Moſt of them ſeemed to have loſt their coheſion, and had a taſte reſembling that of high-roaſted coffee.

In the laſt ſtage of charring the Malt, I ſet thereon a Wine-glaſs inverted, into which aroſe a pinguious, oily matter, which taſted very ſalt. Perhaps it may not be unneceſſary to ſay, that the length of time this experiment took up, was four hours, and that the effect it had, both on myſelf, and on the perſon who attended me, was ſuch as greatly reſembled the caſe of inebriation.

Though, from hence, it is not poſſible to fix the exact degree of heat in which Malts charr, yet we ſee ſome black appeared when the

Thermometer was at 165 degrees; that ſome were intirely black at 175 degrees, and at 180 degrees; that the Grains, thus affected, were ſuch as had been perfectly germinated, and that thoſe which bore a greater heat were defective in that point: from whence we may conclude, with an exactneſs that will be ſufficient for the purpoſes of Brewing, that true germinated Malts are charred in heats between 175 degrees, and 180 degrees; and that as theſe correſpond to the degrees in which pure Alcohol, or the fineſt ſpirit of the Grain itſelf, boils, or diſengages itſelf therefrom, they may point out to us the reaſon of Barley being the fitteſt Grain for the purpoſes of Brewing.

SECTION

SECTION XI.

Of the different Properties of MALT.

THE conſequences reſulting from the before-mentioned experiment, will, perhaps, ſhew it to be one of the moſt uſeful that can be performed by the Brewer.

By the Malt charring and becoming black with the ſame degree of heat in which Alcohol boils, and the effect the vapours riſing from them had on the perſons attending the experiment, it appears, that this ſpirit was reſident therein, and parted therefrom, when it came to the heat of

ebullition; whence, if dry and moiſt heats are capable of producing ſimilar effects as to the circumſtance of preſervation, then ought not this Grain, when in poſſeſſion of the whole of its properties as Malt, to be made to endure ſuch moiſt heats as are equal to 175 degrees, becauſe they would deprive it of this ſpirit, its moſt preſervative part: but as in fermentable Muſts this ſpirit is not required to appear diveſted of the other properties of the Grain, it ſhould rather be intimately mixed with ſuch as are neceſſary to ſoften, ſheath, and retain it the neceſſary time.

Germinated Barleys, ſo little dried as that their particles are not removed beyond their ſphere of attraction, from

from their not being in a preſervative ſtate, cannot properly be termed Malts.

We have before ſeen that the firſt degree of dryneſs which conſtitutes them Malts, is that alſo which occaſions them to cauſe ſome effervescence; and that this cannot be effected when they are dried with leſs than 120 degrees of heat, which is alſo the higheſt degree of heat that leaves them white. When urged by a Fire of 175 degrees, they begin to charr and turn black; now this difference in heat being but 55 degrees, and producing in the Grain ſo great an alteration as from white to black; with a little practice the different ſhades or colours belonging to each

reſpective degree of heat, cannot eaſily be miſtaken.

White, according to Sir *Iſaac Newton*, is a compoſition of all colours, as Black is ſaid to be owing to the abſence of light; and theſe two indicate the two extremes of the dryneſs of Malt. The colour with which a middling heat affects it is Brown; and this being compounded of Yellow and Red, to ſpeak according to accepted terms, the four colours which ſhade Malt differently, in proportion to its dryneſs, are White, Yellow, Red, and Black. The following Table, conſtructed on theſe principles, will, on macerating the Grain, readily inform the practitioner of the degree

degree to which his Malts have been dried.

A TABLE of the different Degrees of the Dryneſs of Malt, with the Colour occaſioned by each Degree.

Deg.		
119	W.	White.
124	W. W.	Yellow.—Cream Colour.
129	W. Y.	Light Yellow.
134	W. W. Y. Y.	Red.—Amber Colour.
138	W. Y. R.	High Amber.
143	W. Y. Y. R. R.	Pale Brown.
148	Y. R.	Brown.
152	Y. Y. R. R.	Black.—high Brown.
157	Y. R. R. B.	Brown, inclining to Black.
162	Y. R. R. B. B.	high Brown, ſpeckled with Black.
167	R. B.	Blackiſh Brown, with Black Specks.
171	R. B. B.	Colour of Burnt Coffee.
176	Black.	Black.

The ſeveral letters againſt each degree, it's apprehended, will the better help to fix the colour.

The above Table not only ſhews us how to judge of the dryneſs of Malt from its colour, but alſo, when a Griſt is compoſed of ſeveral ſorts

of Malt, what effect the whole will have when blended together by extraction: and though poſſibly ſome ſmall errors may ariſe in judgments thus formed by our ſenſes, yet as Malts occupy different volumes in proportion to their Dryneſs, in the practice of Brewing if the reſult of the Water, coming in contact with the Malt, ſhew the degree expected, ſuch parcel of Malt may be ſaid to have been judged of rightly in the Dryneſs it was eſtimated to; ſo that the firſt trial either confirms or ſets us numerically right as to our opinion thereof.

But though Malts dried to 120 degrees, are in a preſervative ſtate, yet are they the leaſt ſo as Malts; and as ſuch poſſeſs the whole of their Acids;

Acids; which occaſions their Fermentations and Frettings often to return of themſelves, and with more violence: hence the Wines formed from ſuch are not of long duration, but ſoon become ſour. If the heat which extracted the Malt is kept in proportion to that which dried them, even tho' the Fermentation be very coolly carried on, and tho' the Ales or Beers be brewed in the moſt favourable ſeaſon, they, in great meaſure, arrive at a ſtate of ripeneſs in ſo ſmall a ſpace of time as two weeks. We may therefore conſider this as the extreme for obtaining a liquor which in the leaſt time will be fit for uſe.

As where Malts charr and become black, their parts are ultimately divided, ſo they can ſcarcely poſſeſs any

any Acids, nor conſequently be ſuſceptible of Fermentation: for Fermentation is a diviſion of the parts of the body fermented, and that cannot admit of a diviſion which is minutely divided already. The degree of heat then, prior to that which produces this effect, is the laſt which ſtill retains part of the fermentable properties; and in Malts thus highly impreſſed by Fire, this act would proceed with ſo ſlow and reluctant a pace, that, in this caſe, the liquor may be ſaid to be in the utmoſt ſtate of preſervation: but no time can be fixed for a duration of this ſort, as if brewed with a heat ſimilar to that which dries the Malt, it might keep many years, and thus become more ſubſervient to the temperature of the place it was depoſited in, than to its con-

conſtituent parts. For this reaſon, as experience has ſhewn, two years are the limited ſpace for Drinks made from Malts dried with 162 degrees of heat, before they be in their moſt perfect ſtate; at which degree of heat they become firſt ſpeckled with Black, and ſome of their fineſt parts begin to charr. From theſe two extremes, and on ſuch principles, is the following Table formed, exhibiting the length of time that Drinks made from Malts of each reſpective degree of Dryneſs, brewed properly, and in the moſt favourable ſeaſon, will require before ſuch Drinks come to their due perfection of fitneſs to be uſed.

A TABLE,

A TABLE, ſhewing the Age Beers will require, when properly brewed from Malts of different Degrees of Dryneſs.

Deg.		
119	White.	2 Weeks.
124	W. W. Yellow.	1 Month.
129	W. Y.	3 Months.
134	W, W. Y. Y. Red.	4 Months.
138	W. Y. R.	6 Months.
143	W. Y. Y. R. R.	6 Months.
148	Y. R.	10 Months.
152	Y. Y. R. R. Black.	15 Months.
157	Y. R. R. B.	20 Months.
162	Y. R. R. B. B.	2 Years.
167	R. B.	
171	R. B. B.	
176	Black.	

It muſt be obſerved, that the foregoing Table is conſtructed only on the properties of Malt ſuppoſed to be brewed and fermented with the utmoſt care, with the intervention of Hops; an ingredient which ſhall be conſidered in its proper place. What is meant by the *Extracts being*

ing in proportion to the Dryneſs of Malt, may merit ſome farther explanation.

Grapes, when ripe, carry with them the Water they have received, both during their ſtate of growing, and that of their maturity, which is ſufficient to form their Muſts with. To dried Grapes, or Raiſins, Water is applied, becauſe they are deficient in this property; as, for the ſame reaſon, it is requiſite in regard to Malt: but as Grapes ſtood in no need of artificial Fire to ripen their principles, ſo what they produced themſelves, and cold Water, or what is nearly ſo, added to dried Raiſins, is a ſufficient menſtruum to extract them. But Barleys requiring the aſſiſtance of a great heat to bring their parts

parts to ſuch proportions as will give them a preſervative quality, require alſo a ſimilar heat in the Water to help to digeſt them: but here they are conſidered as not aſſiſted by the effect of Hops, which, when they take place, yielding abundance both of Salts and Oils, require other proportions in the Extracts, and ſuch as create a likeneſs to the Dryneſs of the Malt, and a regard to be had to the effects of the Hops alſo.

But we often ſee liquors brewed from very pale Malts, preſerve themſelves for a long time; and we alſo ſee brown Malts ſo managed as to diſappoint us as to the time their liquor ſhould preſerve itſelf ſound. The firſt of theſe caſes is when the Extracts are made with very hot Water,

ter, as the latter is when the Water is too cold for this purpoſe: for as heat, either moiſt or dry, beſtows the preſervative quality, 'tis the medium of the dryneſs of the Malt, and of the heat of the Extracts, that, in this caſe, the Table indicates, by means whereof it ſhews the ſpace of time the liquor may be expected to keep, before it be full ripe.

Well-brewed Drinks ſhould not only preſerve themſelves ſound their due ſpace, in order to be meliorated by time, but, as the moſt certain ſign of the Artiſt's ſkill and care, as well as of the ſalubrity of the Drink, they ſhould be fine and tranſparent; this ſign comprehending the whole of a well-formed Muſt, and of a perfect Fermentation. If then the rules for ob-

obtaining theſe ends can be deduced from the foregoing principles, and the laſt-recited experiment, and theſe be ſtrengthened by the ideas of men who beſt underſtand Nature and her laws; we may then flatter ourſelves with poſſeſſing a Theory which will anſwer our expectations in practice.

Between the parts of opake coloured bodies (ſays Sir *Iſaac Newton)* are many ſpaces repleniſhed with mediums of other denſities; as Water between the tinging corpuſcles wherewith any liquor is impregnated; and the diſcontinuity of parts is the principal cauſe of the opacity of bodies. Salts undiſſolved, and without a medium, form an opake body, as alſo Oils not perfectly incorporated with Water; from whence we may con-

conclude, that all Muſts which are not ſaponaceouſly formed, or whoſe conſtituent parts are not diſſolved into one homogeneous body, are not fit either for a perfect Fermentation, or to produce a pellucid liquor; and ſaponaceous bubbles, ſays the ſame Author, will, for a while, appear tinged with a variety of colours, which are agitated by the external Air; and thoſe bubbles continue until ſuch time as, growing exceſſive thin by the Water trickling down their ſides, and being no longer able to contain the incloſed Air, they burſt. As they thus vary their denſities in proportion to their duration, the colours they reflect muſt alſo continually vary: and hence ariſes the impoſſibility of judging of the condition or ſaponaceouſneſs of Ex-

tracts of Malt from the appearance of their froth. This, indeed, has, for a long time, none other being known, been accounted the beſt method: but in deference to the opinion of ſo great a man, it ſhould, at preſent, give way to the uſe of the Thermometer, which is the only inſtrument by means whereof we can obtain clear and fine Beers, as it enables us numerically to fix the heat of the liquors we extract with.

When Extracts are made without the proper degree of heat, that is, when either the Malts are not ſufficiently dried, or the Water is not powerful enough in heat, the Oils of the Malt do not mix perfectly with the Water, and the liquor is deficient in tranſparency.

On

On the other hand, Extracts made with Waters ſo hot that the conſtituent parts are thereby removed beyond their ſphere of attraction, or the Oils coagulated ſo as to form a body ſeparate from the Water, muſt needs be opake. Worts or Muſts can never, in either of theſe caſes, yield a tranſparent Wine; whereas with a due heat, which ſhould be the medium of theſe two, they muſt be perfectly ſo; and as they remove from ſuch medium, they will be more or leſs valuable.

Length of time, which improves Beers and Wines, often rectifies our errors in this reſpect; for the Oils being, by various frettings, more attenuated, and more intimately mixed, the liquor is, by this means, often

ten reſtored, or rendered homogeneous; yet I never found this to ſucceed, where the error on the whole of the dryneſs of the Malt, and the heat of the Extracts exceeded the medium, for this purpoſe, by 14 degrees.

Art alſo has, in ſome meaſure, remedied this defect. For when Beers or Wines are ſuffered to ſtand till they are rather in an attracting ſtate, than in a repelling one, that is, till their Fermentations and Frettings have had their courſe; then, if they do not fall ſpontaneouſly fine, they may be precipitated, by mixing therein a fluid body more ponderous than the liquor: all the floating particles, that occaſioned its foulneſs, are, by this means, made to ſubſide

to

to the bottom, and leave a limpid Wine: but the power of diſſolved Iſinglaſs, the ingredient generally uſed for this purpoſe, ſeldom takes effect above a medium, as before, of 14 degrees.

Indeed, other ingredients have been uſed, which carry this power near 10 degrees farther. Whether ſuch things be ſalutary, is not my province to determine: it would undoubtedly be better if there were no occaſion for them: but beyond the limit precipitation hath no effect; as the liquor which cannot be fined thereby, if attempted by increaſing the quantity of the precipitants, muſt be injur'd in the taſte, which will be over-power'd by the menſtruum. How frequent this laſt caſe of *cloudineſs* is, would anſwer

no purpoſe, in this place, to enquire. The uſe of doubtful ingredients, and ſuch errors as have been mentioned, need no longer blemiſh the art, when a conſtant and happy practice will be both the effect and proof of a ſolid and experimental Theory.

Beers which become bright of themſelves, or by time alone, as well as thoſe precipitated with diſſolved Iſinglaſs, and others with more powerful ingredients, each poſſeſs their peculiar properties in a certain latitude, or number of degrees; and as theſe effects ariſe wholly from the heats employed in drying the Malts and in forming the Extracts, the following Table will be of uſe to point them out.

A TABLE,

A TABLE, ſhewing the tendency Beers have to become fine, when properly brewed from Malts of different Degrees of Dryneſs.

119—White. 124—Cream Colour. 129—Light Yellow. 134—Amber Colour.	Latitude of pale Malts, which, when properly brewed, become ſpontaneouſly fine, even ſo far as 138; when brewed for Amber, by repeated Fermentations, they become pellucid.
138—High Amber. 143—Pale Brown.	By Precipitation theſe grow bright in a ſhort time.
148—Brown. 152—High Brown.	With Precipitation require 8 or 10 Months to be bright.
157—Brown, inclining to Black. 162—Brown, ſpeckled with Black.	With Precipitation theſe may be fined, but will never become bright.
167—Blackiſh Br. ſpeckled Black. 171—Colour of burnt Coffee. 176—Black.	Theſe, with difficulty, can be brewed without ſetting the goods, and will, by no means, become bright, not even with the ſtrongeſt acid Menſtruum.

Thus doth the ſucceſs of this Art depend on the inſtrument ſo often mentioned: which, by pointing out the difference of expanſion cauſed by different heats, becomes a ſure guide. I ſhall now cloſe this account of Malts, as I did that of Fermentations, by comparing with theſe principles the defects which we but too often meet with in Barley when malted.

SECTION

SECTION XII.

Obſervations on Defective MALTS.

IN the preceding enquiry ſome of the Defects of Malts have been occaſionally mentioned: but as a perfect knowledge of the Grain, eſpecially when it hath undergone this proceſs, is a matter of no ſmall concern to the Brewer, I ſhall now bring ſuch defects into diſtinct view, both to compare them with the foregoing principles, and that they may be more at hand, on every occaſion, when wanted.

Every different degree of heat acting on bodies cauſes a different effect; and this

this varies alſo, as ſuch heat is more or leſs haſtily applied. The proper act of germination is when the moiſture given to the Grain is not excited by too much warmth; for in the ſame proportion as the warmth is, the veſſels muſt be diſtended; and if the motion is violent, they more greedily imbibe the coarſer Oils, and in greater quantity: by this means the glandular parts of the vegetable are filled with ſulphurs leſs delicate, and of greater ſpiſſitude; and theſe being to form the ſaccharine ſalts, with the greater briſkneſs this act is carried on, the leſs ſweet, and the coarſer will theſe ſalts be when dry, even often tending to a bitter. For theſe reaſons, if I may be permitted the diſtinction, I apprehend there is a material

one

one between Germination and Vegetation. The former ſeems to be the act cauſed by heat and moiſture, while the plume or acroſpire is ſtill enveloped within the teguments of the parent Grain, which is moſt perfectly performed by the gentleſt action, and the leaſt heat that is capable of moving the different principles of the Grain in their due order. Vegetation again is that act when the plant iſſues forth, and, being rendered ſtronger by the impreſſions of the Air, becomes capable of reſiſting its inclemencies, or the warmth of ſun-ſhine. Germination is the only act neceſſary for malting, the intention being ſolely to put in motion the properties and principles of the parent Corn, and not to puſh up the embryo to a plant: now, as this begins

begins in Barley at the degree where Water begins to be fluid, or nearly ſo, the cold ſeaſon, when the Thermometer ſhews from about 32 to 40 degrees, is moſt proper for this purpoſe, and to render the ſalts truly ſaccharine. How far its latitude may, with propriety, be extended, experience alone muſt determine. Maltſters continue to work as long as they find the Seaſon proper, and leave off generally in *May*, when the heat of the Water is, at a medium, from 50 to 55 degrees. But the nearer they come to this medium, with the greater diſadvantage muſt they malt: ſo that we may conclude it to be an original defect in Malt, if it be not germinated in the cold ſeaſon, as otherwiſe its ſaccharine parts

parts muſt be impreſſed with a diſagreeable taſte.

Malt which hath not had a ſufficient time to ſhoot, ſo that its plume may have reached to the extent of the inward ſkin of the Barley, will have remaining therein too large a quantity of Earth and Oils, which would otherwiſe have been expended in the acroſpire and radical veſſels; and all thoſe parts of the Corn which have not been ſeparated, and put in motion by the act of Germination, will, when laid on the kiln to dry, harden and glutinize; ſo that no greater part thereof will be ſoluble in Water, than ſo far as the ſtem or ſpire of the Barley riſes to, or very little farther, and as much as is wanting thereof, will be juſt ſo much loſs to the Brewer.

When

When Malts are ſuffered to grow too much, or till the ſpire ſhoot thro' the ſkin of the Barley (which is not often the caſe) tho' all that is left be Malt, that is, contains Salts diſſoluble in Water; yet as too large a portion of Oils hath been extracted out of the Grain, ſuch Malts cannot be fit to brew Drinks for long keeping; beſides the loſs of the ſubſtance of the Corn occaſioned by its being overgrown.

Malts which have been but juſt enough grown, and have been duly worked on the floors, if not thoroughly dried on the kiln, even tho' the Fire be excited to a proper heat, muſt retain many watery parts, which will cauſe the Corn, when laid together, to germinate afreſh; perhaps to

to heat and take fire: ſhould it continue long in this ſtate, it muſt, at leaſt grow mouldy, and have an ill flavour.

Malts well grown, and worked as before, but over dried, though with a proper degree of heat, will become of ſo tenacious a nature, as to require a long time before they can admit the outward impreſſions of the Air to relax or mellow them, that is, before they be fit to be brewed with all the advantages they otherwiſe would have.

Malt dried on a kiln not ſufficiently heated muſt require a proportionably longer time to receive the proper effect of the Fire; which if it have not, it will be in the ſame caſe

caſe as Malt not thoroughly dried, as above.

If too quick or fierce a Fire be employed to dry Malt, inſtead of gently evaporating the watery parts of the Corn, it torrifies the outward ſkin thereof, ſo rarefies the incloſed Air as to burſt the veſſels of the Grain, and divides the outward ſkin from the body of the Corn, (ſuch are called *Blown Malts)* by which means it occupies a larger ſpace. If ſuch a Fire be continued, it even vitrifies ſome parts of the Grain, from whence the Malt is ſaid to be *Glaſſy*. Malts, which from their being thus hardened, are rendered of a ſteely nature, will not diſſolve, or but in a ſmall proportion, and are very troubleſome and dangerous in brewing, as

as they frequently occaſion a total want of extraction, which is termed, *Setting the Griſt.*

Malts juſt, or but lately taken off the kiln, generally remain warm for a conſiderable time. But till they become equally cool with the ſurrounding Air, they cannot be ſaid to be mellow, or in a fit ſtate to be brew'd; for as their parts will be harſh and brittle, the whole of their ſubſtance cannot be reſolved, and the proper heat of the Water, which ſhould be applied to them for that purpoſe, is therefore more difficult to be aſcertained. The practice of thoſe Maltſters, who ſprinkle Water on Malts newly removed from the kiln, to make them appear as having been

made a conſiderable time, or, as they term it, to *plump* them, is a deceit which merits attention; for by this practice the circumſtance of the heat, and harſhneſs of the Malt, is only externally and in appearance removed, and the purchaſer groſsly impoſed on; as by being thus treated it occupies a greater volume, and, if not ſpeedily uſed, ſoon grows mouldy, heats, and is greatly damaged.

The direct contrary is the caſe of high-dried Malts, which have been made a long time: the dampneſs of the Air hath relaxed them, and ſo much moiſture hath inſinuated itſelf into the Grain, that it cannot readily be aſcertained how much hotter the Maſh ſhould, for this reaſon, be.

be. But ſuppoſing no diſtemper, ſuch as being mouldy, heated, or damaged by vermin, Malts in this caſe may more certainly be helped in brewing, than thoſe juſt above-mentioned. It appears, therefore, how neceſſary it is to procure Malts which have been wetted and germinated to their true pitch, dried by a moderate heat, raiſed to its true degree, ſo as the moiſture of the Corn may be duly evaporated, then cured ſo as to preſerve themſelves a due time, without being blown, vitrified, or burnt by too hot or haſty Fires. How eaſy it is to regulate this proceſs in the ciſtern, on the floors, and on the kiln, when the Maltſter uſes no artifice to ſave his exciſe, I need not explain. But with what certainty and ſkill the whole might be

carried on by the help of the Thermometer, I leave ſuch to ſay, who are modeſt enough to think, that the Art may be brought to more accurate rules than thoſe of the determination of our unaſſiſted ſenſes. As ſuch rules may eaſily enough be deduced from what hath been ſaid, I ſhall not be particular in laying them down here; that not being my immediate purpoſe, nor my buſineſs as a Brewer; and eſpecially as I have neither leiſure, nor the conveniency of a Malt-houſe, to make experiments of this ſort; yet I may, with great truth, ſay, that ſuch as would not be diſappointed in their brewing, muſt take care not to be deceived in their Malt. This, however, being but too frequently the caſe, it is undoubtedly beſt to treat faulty

faulty Malts by the ſame rules as if they were perfect; by which means the well-malted parts alone will be digeſted. If they be too ſlack dried, they may be corrected by an addition of heat; and if over dried, or injured by Fire, they may be proportionally helped in the extracts; of which the Brewer will be beſt enabled to judge from his firſt liquor, by applying the Thermometer thereto, and this to a ſufficient degree of exactneſs.

I flatter myſelf ſome ſatisfaction muſt ariſe from ſeeing both what is perfect, and what is defective in the principal proceſſes of this Art agree ſo well with its Theory, as theſe are ſo many proofs of its certainty; and though there be ſeveral incidents (as yet

yet unmentioned) inſeparable from the practice thereof, theſe will only ſerve to confirm this truth, that when our taſk is to imitate *Nature*, it is our duty, by ſtudy, to inform ourſelves of, and induſtriouſly to practiſe, her laws.

F I N I S.