AN ANALYSIS OF THE MEDICINAL WATERS OF TUNBRIDGE WELLS.

LONDON:

PRINTED FOR J. MURRAY, NO. 32, FLEET STREET.

1792.

ADVERTISEMENT.

This pamphlet originated in the following circumſtance. By the direction of the Proprietor of the medicinal waters at Tunbridge Wells, a cover had been placed over one of the ſprings, with a view to defend it from any foreign matter, which either wantonneſs or accident might introduce. In conſequence of this, a queſtion arofe, whether or not the fpring, thus covered, might be fuppofed to be, in any refpect, altered in its qualities. In order to decide this queftion, the Author inftituted a comparative Analyfis of the two fprings, and proved, by the moft fatisfactory experiments, that the only advantage, that can be derived to the fpring by a cover, is cleanlinefs; and, that the water is not alterable by its being either expofed, or covered, fo long as fuch covering does not entirely exclude the external Air.

The Proprietor, in compliance with the general opinion, removed the cover, and the original object of the prefent publication was thus fuperfeded. The Author however, finding himfelf under fome fort of engagement to fatisfy the curiofity of friends, and reflecting, that no accurate Analyfis of the Tunbridge waters had hitherto been given, now offers to the public thefe pages as the refult of careful experiments; wifhing at the fame time not to appear to have been inattentive to this particular fubject: fince it is not unreafonable to fuppofe, that a fcientific enquiry into the component parts of thefe fprings may, in fome meafure, affift us with refpect to the right application of them in medicine.

He likewiſe takes this opportunity of publicly acknowledging his obligation to the ingenious Mr. Babington, of Guy's hoſpital, by whoſe ſkill and dexterity in executing chemical experiments, he was greatly aſſiſted in the Analyſis.

INTRODUCTION.

It may not be amiſs, previous to our ſtatement of the analyſis of theſe waters, to mention, for the information of thoſe who have not the opportunity of viſiting them, or of conſulting the authors that have written on the ſubject, that the ſprings from whence they flow are ſituated in a village about thirty-five miles ſouthward of London, in a valley ſurrounded by a number of hills, which, though formerly wild and barren, are now, for the moſt part, cultivated, and many of them richly inhabited.

Theſe hills ſeem to be chiefly compoſed of a crumbling, ferruginous ſandſtone; and, for ſeveral miles around, iron has been diſcovered in great abundance. Upon the original diſcovery of the ſprings (which is ſuppoſed to have been about the year 1607) we are told they were numerous. At preſent, however, there are only two in uſe, which riſe within a few yards of each other in the centre of the valley, and yield each about a gallon of water in a minute.

For many years the water was collected in two *open* ſtone baſons, perforated at the bottom, and placed in ſuch a manner over the ſprings, that, as the water roſe, it flowed into the baſons from below, whilſt the waſte water paſſed off by means of notches made in the edges of the baſons for that purpoſe. But very lately *one* of theſe has been changed for a baſon of marble, over which is fitted a marble dome, ſo as to incloſe it completely, except at the marginal notch, or opening, which gives exit to the water nearly as uſual. This alteration, inconſiderable as it may appear, has given rife, it feems, to a difference of opinion; *fome* conceiving that by thus excluding the contact of the atmofphere, the water was not likely to lofe fo much either of the elaftic fluids it contained, or of its properties as a chalybeate; *others*, that by being deprived of the cuftom of dipping their veffels into the fpring (as *formerly*) they have not the water fo near the fountain-head, and confequently not fo frefh and efficacious.

How far thefe opinions may be reconciled, will be feen by the analyfis here fubmitted; which, it is hoped, will alfo determine two other material pofitions, much difputed by authors; namely, whether there be any effential difference between the waters of the *two* fprings, as they originally ftood; and what is the true nature of their *impregnation*.

For the more concife and perfpicuous relation of the experiments which have been made on this fubject, let the inclofed fpring be expreffed by the letter A; the open, by B; and the *inclofed* one (after having been uncovered about twelve hours) by C: and let it be underftood, that by a *meafure* of any liquor employed, is meant a quantity exactly afcertained in a cylindrical glafs-jar, graduated and kept for that purpofe.

OF THE ANALYSIS.

In the proceſs of this analyſis, the firſt thing attended to was the ſenſible properties of the waters. In this reſpect no difference whatever could be obſerved between A and B. The water of *both* was equally clear and tranquil; they had *both* a diſtinct chalybeate ſmell and taſte, and were *both* found, by an accurate thermometer, to be at a temperature of 50°. There was alſo obſervable an equal ochry depoſit on the channels leading from the reſpective baſons, as well as on the ſides and bottoms of the baſons themſelves. This ſimilarity being noticed, the following experiments were made on A and B, nearly, though not exactly, in the order in which they are here related.

EXPERIMENT THE FIRST.

EQUAL meaſures of the water, taken immediately from the wells, were expoſed in open glaſſes about ten hours, in a room at a temperature of 55°; at the end of which time the internal ſurfaces of the glaſſes were univerſally ſtudded with air-bubbles, and the water in both was covered with a purpliſh ſhining pellicle. The air-bubbles were ſmaller, but more numerous, in B than in A; and the pellicle was ſeemingly more copious.

EXPERIMENT THE SECOND.

EQUAL meaſures of an infuſion of galls being added to equal meaſures of the waters, a beautiful purple-colour was produced, after a few ſeconds; in *both* ſo very ſimilar in ſhade, that it was impoſſible to ſay which of the two was the deeper.

EXPERIMENT THE THIRD.

A SOLUTION of Pruſſian lime, employed in the ſame way, changed them *both* to a light blue, of no apparent difference.

EXPERIMENT THE FOURTH.

INFUSION of litmus was equally and almoſt inſtantly changed, by *both*, to a light red or garnet colour.

EXPERIMENT THE FIFTH.

WITH ſyrup of violets no ſenſible alteration could be perceived at firſt; but, on leaving them to ſtand ſome time, the blue colour of the violet was altered to a green.

EXPERIMENT THE SIXTH.

By a ſolution of acid of ſugar no viſible effect was produced in *either*.

EXPERIMENT THE SEVENTH.

On the addition of a ſolution of muriated barytes, a cloudineſs immediately took place, not however to a greater degree in *one* than in the *other*.

EXPERIMENT THE EIGHTH.

Nitrous ſolution of ſilver occaſioned at once an evident precipitation. The precipitate was at firſt of a pearl-colour, but, on remaining expoſed to the light for a few hours, it became of a muddy blue. In neither of theſe reſpects was there any diſtinction to be obſerved.

EXPERIMENT THE NINTH.

By a ſolution of ſoap in ſpirit of wine *both* the waters were rendered wheyiſh.

EXPERIMENT THE TENTH.

The ſame appearance was effected by a ſolution of ſugar of lead.

EXPERIMENT THE ELEVENTH.

By volatile tincture of ſulphur they were immediately changed to a deep bottle-green.

EXPERIMENT THE TWELFTH.

Lime-water rendered *both* ſlightly turbid, and produced a light yellowiſh brown colour; as did alſo the mild alkaline ſolutions.

EXPERIMENT THE THIRTEENTH.

THERE was neither precipitation nor effervefcence difcernible in *either* from concentrated vitriolic acid, nor any vifible effect from arfenic or corrofive fublimate.

EXPERIMENT THE FOURTEENTH.

ON trial of the waters, after expofure (experiment 1ft) with the tincture of galls, Pruffian lime, and infufion of litmus, the fame changes took place as in experiments 2d, 3d, and 4th, though not in fo great a degree; the fhades of colour appearing now confiderably weaker. Thefe experiments having been made on A and B, were all (except the firft) repeated on B and C, with precifely the fame refult. In no inftance could the flighteft variation be perceived.

EXPERIMENT THE FIFTEENTH.

Two great decanters, filled under the ſurface of B and C, and inverted into two baſons, were ſet in this ſituation before an open fire, where they continued between three and four hours. Here it was obſerved, that as the water grew hot, there was extricated from it a quantity of air, which collected itſelf in the ſuperior part of the decanters; and, in proportion as the air was ſeparated, the water became turbid, and at laſt, when it had acquired nearly a boiling heat, it was found to be altogether ochry. While the decanters were hot, the air occupied a ſpace of ſeveral cubic inches in each, but being cooled down to the temperature of the atmoſphere, there did not appear to remain above two cubic inches in both.

EXPERIMENT THE SIXTEENTH.

A GALLON of the water of A, boiled for a few minutes in an open veſſel, became ochry throughout, as in the laſt experiment. Being filtered, it was found incapable of producing any alteration in the infuſion of litmus, or of ſhewing any effect whatever with the tincture of galls, or Pruſſian lime. The whole ochre collected by the filter proved, when dried, to be ſtrongly *magnetic.*

EXPERIMENT THE SEVENTEENTH.

Two quarts of the above filtered water were evaporated down to four ounces, without yielding a further depoſition of any kind, the liquor, even when cooled, remaining perfectly tranſparent. The nitrous ſolution of ſilver and muriated barytes both now produced a copious precipitation, but ſtill the acid of ſugar ſeemed to have little or no effect.

EXPERIMENT THE EIGHTEENTH.

To aſcertain the proportion of ſolid contents to a given quantity of the water of A, two gallons of it boiled and filtered, as in experiment the 16th, were carefully evaporated to dryneſs, and yielded exactly eight grains of reſiduary matter; the ochre collected by the filtre, when dried, weighed only two grains.

EXPERIMENT THE NINETEENTH.

THE reſiduary matter of the laſt experiment, digeſted for twelve hours in four ounces of alcohol, was found ſoluble in this menſtruum, in the proportion of three grains and a half to four grains and a half. What the ſpirit left undiſſolved being afterwards digeſted, for the ſame length of time, in two ounces of diſtilled water, there was left but one grain of inſoluble matter, which was perfectly inſipid to the taſte, and inſoluble in diluted marine acid.

EXPERIMENT THE TWENTIETH.

On the evaporation of the alcohol of the preceding experiment, the reſiduum was found to be deliqueſcent, and of a bitter ſaline taſte; it gave out abundance of white elaſtic pungent fumes on the application of vitriolic acid; produced an inſtant precipitation on a particle of it being dropped into the ſolution of nitrous ſilver; and, when diſſolved in water, yielded, on the addition of a little vegetable alkali, a light white earthy precipitate, which, diluted vitriolic acid readily rediſſolved.

EXPERIMENT THE TWENTY-FIRST.

THE evaporation of the water (experiment 19th) afforded a very different refult; when it was reduced to about two drachms, there appeared upon the furface a thin faline pellicle, which, from its difficult folubility and infipidity, and more efpecially from its affording a precipitate as well on the addition of acid of fugar as muriated barytes, proved to be *felenite*. This continued to feparate from the liquor till the whole was evaporated to drynefs, when it was found that, befides the felenite, there remained a fmall proportion of common falt, too fmall to be eftimated by the balance, but perfectly diftinct to the tafte, and appearing in well defined cubes when a drop of the folution was placed under the microfcope.

EXPERIMENT THE TWENTY-SECOND.

A SMALL matraſs, containing four ounces by meaſure, and having a glaſs ſyphon accurately fitted to it, was filled under the ſurface of the water of C, and, whilſt perfectly full, the extremity of the ſyphon was paſſed under a glaſs jar, filled in the ſame manner under water, and inverted into a ſmall baſon. The veſſels being thus connected, the water in the matraſs was afterwards made to boil, by means of a lamp, for about five minutes, when there was found collected in the jar half a cubic inch of air, the water having undergone the ſame change, as mentioned in experiments 15th and 16th. This air, upon being paſſed through lime water, was diminiſhed two thirds in its bulk, and occaſioned an inſtant precipitation of the lime; the remaining part of the air was found incapable of ſupporting flame, but ſuffered a ſmall diminution of bulk on mixture with nitrous air. In theſe reſpects the water of B, upon trial, appeared the ſame.

EXPERIMENT THE TWENTY-THIRD.

ON comparing the ſpecific gravity of B with C, they were found to correſpond exactly, and to exceed that of diſtilled water in the proportion of 713° to 712°.

HAVING thus finiſhed the account of the experiments made on theſe waters, let us now ſee to what concluſions they will lead.

In the firſt place then it is proved, agreeable to the received opinion, (experiment 1ſt, 2d, 3d, 5th, 11th, 12th, 15th, and 16th), that they contain *iron*, and this in an äerated ſtate, that is, held in ſolution by union with *aerial* *acid*, (experiments 1ſt, 15th, 16th, and 22d); though it appears from a variety of circumſtances, that the quantity contained is not very conſiderable. Only two grains of the calx of iron could be obtained from two gallons of the water, (experiment 18th), which correſponds not only with the purple colour produced by the tincture of galls, (experiment 2d), but alſo with the manner in which this colour took place; as likewiſe with the taſte of the water, which, though diſtinctly chalybeate, is not by any means ſtrongly ſo, when compared with many other waters of this kind. All vegetable aſtringents, as has been long known, change ſolutions of iron to a dark colour, and the galls, as the ſtrongeſt of theſe, do this the moſt readily and perfectly. But it is not only for aſcertaining the preſence of this metal, that we employ this teſt; we may alſo form by it a pretty accurate judgment with regard to proportion. When this is large, the colour changes immediately, and is always black; but when it is inconſiderable, it turns out, more or leſs, of a purple; and if the acid be in exceſs, as we ſuppoſe the äerial acid in theſe waters, ſome time will be required before the colour makes its appearance. To this may be added, the ſlight precipitation produced by lime water, or the alkaline ſolution (experiment 12th); and more eſpecially the light blue colour, which appeared on the addition of Pruſſian lime (experiment 3d): a teſt ſo delicate with regard to iron, that one quarter of a grain may be detected by it in a gallon of water.—The colouring matter combined with lime in this teſt, or, as it is often prepared, with alkali, is what conſtitutes the Pruſſian blue of the ſhops, when united with calx of iron.

It appears equally clear that there is alſo contained in theſe waters a quantity of *muriatic acid* (experiment 8th) partly combined with *magneſia* (experiment 20th), and partly with *foſſil alkali* (experiment 21ſt): in other words, *muriated magneſia* and *common ſalt*; for we know that the preſence of muriatic acid in ſolution is concealed with great difficulty, there being few bodies in nature which combine more readily, or more minutely, than this and calx of ſilver, while the properties of the compound which they form are ſo remarkable, that it is next to impoſſible to miſtake them. One of the moſt characteriſtic of theſe, viz. the change of colour upon expoſure to light, the precipitate (experiment 8th) was found to poſſeſs; which, when connected with the decompoſition reſulting from the application of the vitriolic acid to the reſiduum left by the alcohol (experiment 20th) puts the matter beyond all kind of doubt. Neither can there be any uncertainty with regard to the nature of the baſis to which the muriatic acid is here united; ſince there is no other earth, beſides magneſia, which forms with this acid a bitter deliqueſcent ſalt, and is at the ſame time ſoluble in vitriolic acid; nor any other body which reſembles common ſalt in the properties above-mentioned, except the digeſtive ſalt of Sylvius; which however, in the analyſis of mineral waters, has ſeldom been met with.

If any one ſhould wiſh to be ſatisfied of the degree of minuteneſs to which chymical inveſtigation may be carried, he need not ſeek for a clearer illuſtration than that to which we have juſt referred. Let him take the ſmalleſt viſible particle of any of the ſoluble compounds of muriatic acid, ſuch as common ſalt, common ammoniac, digeſtive ſalt of Sylvius, or any other; and, putting it into a tumbler of diſtilled water, let him add but a ſingle drop of ſolution of nitrated ſilver, and he will preſently be convinced how far chymical diviſion goes beyond the power of any other means the art of man has ever yet deviſed.

The next thing our experiments teach us, is the preſence of a quantity of *vitriolated lime* or *ſelenite*. This appears on the ſimple evaporation of the water (experiment 21ſt), and explains very ſatisfactorily the reſult of experiment the 7th; ſeeing it is the property of heavy earth, or barytes, as it is called, to unite with vitriolic acid, whenever it meets it, and to form therewith a very heavy and inſoluble compound.

Should it be aſked why the acid of ſugar, as delicate a teſt of lime as barytes is of vitriolic acid, did not detect the lime of the ſelenite, in experiment the 6th and 17th; the anſwer is, that it was not allowed ſufficient time to produce its effects. Had the lime been in union with any other acid than the vitriolic, a precipitation would in all probability have taken place immediately; but between this and the acid of ſugar, the attraction of lime is ſo nicely balanced, that we are obliged to wait longer than in moſt other caſes of decompoſition before the ſuperiority of the latter becomes apparent. The truth of this opinion was confirmed by a ſubſequent experiment.

WE come now to ſpeak of the elaſtic fluids or airs. Theſe, as extricated from the waters (experiment 22d), appeared to be of three kinds.

Firſt, *äerial acid*, or fixed air, that which was abſorbed by the lime water.

Secondly, *phlogiſticated air*, or, as the French call it, *moſette*, the reſiduum left

azotic Gas

by the lime water, or rather that part of the refiduum which the water could not abforb (experiments 15th and 22d); and which was found incapable of fupporting flame, or of being diminifhed in bulk by mixture with nitrous air.

Thirdly, *common air*, or that part of the refiduum which nitrous air did diminifh.

When, for example, we find the infufion of litmus changed red (experiment 4th), we fay it is becaufe the äerial acid is in excefs, or that the water contains more of it than the calx of iron can combine with. We fay alfo that the ferruginous pellicle, obfervable on the furface of thefe waters, after expofure (experiment 1ft), and the diminution of their effects in experiment 14th, muft depend upon the feparation of the äerial acid from its union with the calx of iron, in confequence of the alteration of temperature, and the ſtrong propenſity of this acid to aſſume an elaſtic form.

But, however diſtinct theſe may appear upon examination, we muſt not be too haſty in inferring that they exiſt ſo in the compoſition of the water; on the contrary, we have reaſon to ſuſpect that both the phlogiſticated and common air were here produced from the decompoſition of äerial acid: for it is found by experiment, that where this ſubſtance has been imbibed by water, and afterwards ſeparated by the application of heat, it always leaves a reſiduum, on being agitated with lime-water, correſponding very exactly in its properties with that above referred to. Be that as it may, it is this volatile acid which beyond all diſpute gives ſolubility to the calx of iron, with which theſe waters are impregnated; a circumſtance which beſt accounts for many other important phenomena occurring in their chemical hiſtory. Hence certainly the reaſon why ſuch waters cannot be carried in perfection, to a diſtance; and why it has been propoſed, with a view to preſerve their virtues, that a ſmall quantity of elixir, or acid of vitriol, ſhould be added to them at the time of bottling; which, however, though it render their chalybeate properties more permanent, occaſions a material alteration in the nature of the compound, from which theſe properties ariſe. In the ſame manner we explain, why it was neceſſary that a certain time ſhould elapſe before the colour of ſyrup of violets was altered in experiment 5th, and why the boiling was ſo effectual in producing the ochry depoſit (experiments 15th, 16th, and 22d). Had the iron, in theſe experiments, been combined with any other than a volatile menſtruum, it certainly could not have been either ſo readily or ſo completely ſeparated.

Upon collecting then the different ſubſtances, the exiſtence of which ſeems to be demonſtrated by theſe experiments, and eſtimating their proportions as minutely as the nature of ſuch an inveſtigation will admit, we may ſtate that a wine gallon of theſe waters contains,

	Cubic Inches.
Of äerial acid - - -	10 $\frac{6}{10}$
Phlogiſticated air - -	4
Common air - -	1 $\frac{4}{10}$
	16
Calx of iron - - -	1 grain.
Common ſalt - -	$\frac{5}{10}$
Muriated magneſia - -	2 $\frac{25}{100}$
Selenite - -	1 $\frac{25}{100}$
	5

But further; if the experiments be juſt upon which this analyſis is founded, does it not follow that, whatever be the virtues of theſe waters, they are equal in *both* the ſprings, and, that notwithſtanding what ſome may think to the contrary, the alteration made in *one* of them, in the manner already mentioned, has had no effect whatever, either in giving to the water properties which it did not before poſſeſs, or in ſtrengthening or diminiſhing thoſe, for which it has ſo long been remarkable. We find this ſpring, both open and incloſed, compared with the other, under various circumſtances; but no difference whatever could be diſcovered. Their ſenſible properties were the *ſame*; they produced the *ſame* changes on a great variety of the moſt delicate ſubſtances; were affected in the *ſame* way by heat and expoſure; evolved the *ſame* kinds of air, and yielded the *ſame* kind of ſolid contents. In ſhort, they were found alike in every point of view in which they could poſſibly be taken.

It would indeed be difficult to conceive how this ſhould be otherwiſe; for the äerial acid, which every body will acknowledge to be the principal agent here, is heavier than common air, and there is a free communication with the atmoſphere immediately over the ſurface of the water: what then can prevent this acid from eſcaping? Muſt it not, in conſequence of its weight, make its way to the outlet, or aperture, as the water does, and be continually diſſipated? There is no doubt it muſt; and were it not, that the water contained in the baſon, being ſmall in quantity, is undergoing a perpetual change, we have reaſon to believe, that in the ſuperior part of it the effects of expoſure would be ſenſible.

With regard to the manner in which theſe waters may be ſuppoſed to receive their impregnation; it is probable, that the ſpring from which they originate is at a conſiderable depth, within the bowels of the earth, and that the iron which they contain is taken up in their paſſage to the ſurface. We ſuppoſe them, in the firſt inſtance, to be a common water, containing ſelenite, muriated magneſia, and common ſalt, in the ſmall proportions juſt ſtated, together with a quantity of äerial acid, as yet in an uncombined ſtate. After this we ſuppoſe them to paſs through a ſtratum of iron-ſtone, with which (as already obſerved) this country abounds. In this ſtage, and not before, they become chalybeate; and from this time, till they reach the ſurface, the only ſubſtance they meet with, is ſand, which being itſelf ſtrongly impregnated with iron, is rather calculated to improve than impair them. That the ſource is deep, and not ſubject to the changes which are conſtantly going on in the ſuperior ſtrata of the earth, appears from hence, that theſe waters, though covered with a ſandy ſoil, are ſcarcely affected by rain, and are found in other parts of this county, with very little alteration in their properties.

THE END.