



## The Drug Efficacy Index [Q(VPK)] A Novel Parameter To Calculate Theoretically The Efficacy And Efficiency Of Ayurvedic Formulations

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### ABSTRACT

The incorporation of Artificial Intelligence to the field of Medical Sciences considerably enhanced the field of researches. There are many methods to estimate the drug efficacy of various modern medicines based on theoretical as well as the clinical results. The drug efficacy of alternative medicines was never calculated scientifically due to the lack of evidences from clinical trials. The *Ayurvedic* drugs were not only prescribed on the bases of diseases but also on the bases of individual *Prakrti*. The *Prakrti* of each person varies very much and not easy to understand completely in view of modern science. The field of modern medicines also faces challenges to explain the real reason behind the adverse effect of certain drugs that are even fatal to certain people. In this paper a new simple computational method to theoretically calculate the efficacy and efficiency of various *Ayurvedic* formulations is explained. The new term called Drug Efficacy Index [Q<sub>(VPK)</sub>] that is a numerical value calculated based on the *Ayurvedic* principles in view of modern sciences is introduced.

**Keyword:** *Efficacy, Drug Efficacy Index[Q(VPK)], Ayurvedic Formulations, Triphala, Akashavalli, Gonorrhoea, Baldness (Indralupta), Artificial Intelligence*

### INTRODUCTION

The field of medicines is becoming more and more interdisciplinary in nature with the incorporation of many fields of researches. The inventions of information technology enhanced the field of modern medicines very much in many fields. The incorporation of artificial intelligence to the medical research brought a boom of growth not only in the field of research but also in the field of treatment procedures including surgery. The modern medicines even started the new surgical procedures completely governed and performed by robots without the intervention of the hands of surgeons. There are good successful softwares for the help of physicians to select the medicines for effective prescription. Similarly there are many successful methods for the prediction of efficacies of modern medicines based on the incorporation of medical statistics and artificial intelligence. The present paper aims to make use of artificial intelligence and computational methods for the successful and accurate prediction of efficacies of *Ayurvedic* drugs and formulations. The study on many of the formulations based on the philosophical background of *Ayurveda* and successful computations resulted in the invention of a new formula for predicting the efficacies of various formulations. The paper aims to correlate artificial intelligence and other modern scientific concepts with the traditional *Ayurvedic* philosophy without any prejudices.

**The System of Ayurveda:** The system of medicine called *Ayurveda* is one of the main schools of alternative medicines of eastern origin. The word *Ayurveda* is a combination of two Sanskrit words *Ayu* (the life) or the continuity of consciousness and *Veda* (the knowledge). The school of *Ayurveda* accepts the

philosophy of *Sankhya* philosophy that all the matter in this universe is made up of the *Pancabhutas*, the five gross elements and the predominant one decides the character of that matter. According to this system the body and its constituents including *Doshas*, *Dhatus* etc. derived from a combination of these five fundamental elements viz. Earth (*Prthvi*), Water (*Ap*), Fire (*Teja/Agni*), Wind (*Vayu*) and the Ether (*Akasa*). According to the definition the *dosha* is a factor that is not only capable of vitiation itself but also of vitiating other factors of the body and is also a result of the above mentioned five elements.

**The Three Somatic Humors and the Body types:** The three somatic humors or *Tridoshas* viz. *Vata*, *Pitta* and *Kapha* have specific seats and are capable of getting vitiated due to their respective causes and modify the physiological functions to cause the onset of diseases. The three somatic humors are also mentioned in the name *Tridhatu* in Rig-Veda the very old text of human civilization. The system of *Ayurveda* is developed on the very bases of the *Tridosha* theory. Each of these *doshas* has its own impact on physiological functions and is clearly defined in classical texts. Every human being is different from each other in many respects physical characteristics and psychic behaviors but can be grouped according to certain other characteristics based on the predominant *dosha* among the other two and this natural difference or natural state is termed as *Prakrti* of the individual. The different characteristics and natures of each of these groups are well explained in classical texts [1,2,3,4]. The scientific bases for computing the efficacy of *Ayurvedic* formulations are explained below.

**Human Body as Ensemble:** The *Ayurvedic* authorities clearly stated that the equilibrium of these *doshas* is Health and the imbalanced state of them is the Disease. Hence it is crystal clear that these three somatic humors are termed as *Tridoshas* because in the imbalanced state they can vitiate the body leading to the physiological disturbances. This concept is very much comparable to the concept of ensembles that modern scientists use to explain any system of this universe thermodynamically [5]. The *cikitsapurusha* the person under treatment can be considered as a thermodynamic system and the climate and seasons as the environment which is the real environment as evident from the classical texts and their Sanskrit commentaries. Similarly the *Prakrti* of each person is constituted by the *Tridoshas* and the imbalances lead to *Vikrti* and the diseases or discomforts results. The *Ayurvedic* physician prescribes personalized medicines to reestablish the *Prakrti* the inborn character without causing other diseases or discomforts by pacifying the effects of vitiated *Doshas* and thus the discomforts give way to the comforts. This is just comparable to a thermodynamic system in equilibrium (*Prakrti*) get agitated to a system in imbalance (*Vikrti*) when we change the environment that tries to attain equilibrium (*Prakrti*) with the seasonal changes in the environment. Finally when the equilibrium (*Prakrti*) is attained the thermodynamic system seems to rest but is not really resting as we know [6]. It is crystal clear from the classical texts and their Sanskrit commentaries when we read the bases of theory of three somatic humors or the *Tridosha* theory [7]. Not only the body but also the *Tridoshas* are products of food and are evident that these food and drink can cause imbalances and they can also reestablish the equilibrium. Here it is very interesting to remember the very words of Hippocrates that “Let thou food shall be thou medicine”.

**The Matter (*Dravya*) and its Characteristics (*Guna*):** On analyzing the matter concept of *Ayurveda* it is clear that all the matter in this universe can be explained in terms of their *Rasa*, *Guna*, *Virya* and *Vipaka*. The predominant element present among the five elements in the matter determines its characteristics as per the *Ayurveda* philosophy. A well explained portion on *Dravyaguna* is narrated there in almost all the classical texts with prime importance. The different *Rasas* (primary tastes) and *Anurasas* (secondary, tertiary, quaternary, fifth degree and sixth degree tastes) among the six tastes are clearly mentioned for each drug. When we analyze and correlate these *Rasas* to various functional groups of constituent chemical entities it is very clear that all these are very scientifically arranged. The *Virya* can be considered as the very bases of thermodynamic nature of any reactions viz. Hot (*Ushna*) and Cold (*Sita*). It is worthwhile to remember that any physiological processes or chemical processes can be of thermodynamically two types during their actions viz. exothermic and endothermic in nature during the course of their reaction.

## **MATERIALS AND METHODS**

When I interrogated the more I noticed that the basic principles are the more scientific for computing and are even more comparable with modern findings. The theoretical bases of various concepts like ensembles, various thermodynamic principles and various modern rules like Woodward Feiser

rules, Lipinski rules, Weber rules etc. were found much useful in developing the computational method to reach an equation. The results of the comparisons of the definitions of the technical terms like *Aushadha* given in oldest texts and most modern concept of drug according to IUPAC etc. acted as the torchlight [8]. Simple computational methods are used to calculate the Drug Efficacy Index [ $Q_{(VPK)}$ ] a numerical value based on the theoretical background of traditional *Ayurveda*. Many reported clinical studies and formulations were compared on the bases of the *Tridosha* theory of diseases. The theoretical and philosophical concepts for predicting the affinity studies were also supported the studies [9, 10]. The free energy simulations and their individual contributions and the *Tridosha* theory gave an idea to split the efficacy in to individual components according to *doshas* [11].

**The Drug Efficacy Index and its Mathematical Representation:** The statistical thermodynamics introduced a new term called partition coefficient for deriving the mathematical representation of various thermodynamic entities [12]. This gave an idea to compute a mathematical equation to represent the efficacy. The efficacy of *Ayurvedic* formulations may be considered as a function of *Tridosha* which depends on the *Dravya guna* of their constituents. It clearly suggested the possibility of three components to the efficacy when we viewed in an *Ayurvedic* perspective. Modern studies on the efficacies of combination therapy also supported framing up the present concept [13]. Modern scientists also showed the advantages of combination therapy in the treatment of Asthma [14]. A group of researchers started the studies of combination therapy in animal models with good results [15]. There are modern evidences for the recommended use of combination therapies in cardiovascular diseases [16]. The modern studies on combination therapies are limited to small molecules while it is wonderful to believe that the traditional medicines were dealing with effective combination therapies since their beginning in humans with high therapeutic effects. All these scientific concepts and computational drug designing studies supported to compute the mathematical representation for efficacy for *Ayurvedic* formulations. As we know these tastes *Rasas*, thermodynamic nature *Virya* and *Vipaka* (high energy matter formed due to the action of stomach enzymes and heat during digestion) of each matter in the food can affect the equilibrium of *Tridoshas* each component of the efficacy can be computed. The efficacy of the alternative medicines like *Ayurvedic* formulations was explained in the available ancient texts hither and thither in a vague manner and can only be understood with the help of their own technical terms and Sanskrit knowledge. As a result a new scientific term called Drug Efficacy Index [ $Q_{(VPK)}$ ] to the field of medicines is introduced. On solving the equation a numerical value is obtained that can directly measure the efficacy of the various *Ayurvedic* formulations. For these the traditional fundamental theory of *Tridosha* and narrations of various drugs according to their *Rasa*, *Guna*, *Virya* and *Vipaka* and their pharmacological activities were studied carefully and computed a mathematical equation that can give a numerical value which is a direct measure of the efficacy.

## EXPERIMENTAL

In view of these modern scientific concepts a simple mathematical equation based on traditional *Ayurvedic* principles was computed for calculating the efficacy and a new numerical term Drug Efficacy Index [ $Q_{(VPK)}$ ] was introduced to the scientific world that uses the *Rasa*, *Virya* and *Vipaka* of various constituents of *Ayurvedic* formulations in a scientific way more precisely in a Vedic way and compared with the respective clinical diagnosis and prescriptions. From the comparison of the results it is found that using the same equation it is also possible to explain the efficiency of the drug formulations under study. To compute the mathematical equation the following step wise methods were used.

- ❖ The components of the formulation under study are first listed with their respective part percentages. The *Rasa*, *Virya* and *Vipaka* of the each component were listed and graded scientifically.
- ❖ The correlation of these characteristic of constituents of the formulations to *Tridosha* Theory was studied and the individual components of efficacy of the formulations with respect to each *dosha* based on *Tridosha* Theory were computed.
- ❖ Finally the collective result of the formulation known as the Drug Efficacy Index [ $Q_{(VPK)}$ ] was computed.

These stepwise methods were adopted to solve the efficacy equation and the Data Flow Diagram for the entire process is given below (Figure-1).

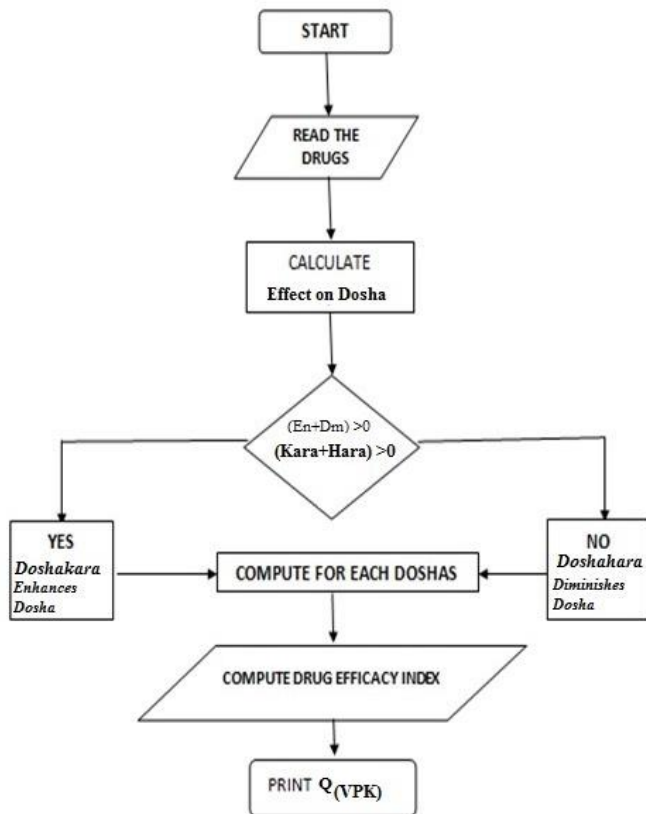


Figure 1. the Data Flow Diagram of the computational process.

## RESULTS AND DISCUSSIONS

Based on the scientific principles a mathematical equation for calculating the efficacy of *Ayurvedic* formulations was computed in a Vedic way that expresses the efficacy as a numerical value. The values were computed for various *Ayurvedic* formulations and few are reporting with comparisons from textual remedies. The computed equation for the Drug Efficacy Index [ $Q_{(VPK)}$ ] of *Ayurvedic* formulations is given below (Figure 2).

Figure 2: Equation for computing Drug Efficacy Index  $Q_{(VPK)}$

$$Q_{(VPK)} = \frac{\sum_{(V,P,K)} q_{(i)}}{100} + \Pi \leq 1$$

Where  $Q_{(VPK)}$  is the Drug Efficacy Index, VPK represents *Vata*, *Pitta* and *Kapha* respectively and  $q_{(i)}$  is the individual components for the *Vata*, *Pitta* and *Kapha* respectively. The  $\Pi$  represents the *Prabhava* the corrective entity that can effectively affect the therapeutic value of the formulation that observed in the real practical world. In most of the cases the value of  $\Pi$  is found to be null and it is needed in special cases (Subject matter for further research). The maximum possible value for the  $Q_{(VPK)}$  is 1 and it is possible only for single *dosha* pacifying drugs and *tridosha* pacifying drugs as evident from the equation. These are ideal drugs for treating the corresponding diseases and are explained as in *Samhitas*. For a comparison of the same the Drug Efficacy Index of the *Triphala* with various part percentages were tabulated (Table1).

The *Triphala*-(1:1:1) is the preparation with the preparation of the powder with the constituents in a same proportion by weight. The other two preparations having controversy as certain practitioners believe they have to be taken by respective weight percentages than number part percentages. When we correctly interpret the respective formulation written in Sanskrit texts we can understand that they must be taken by number percentages as they counted the number to get an approximate weight percentage. The combination *Triphala*-(1:1:1) by weight is having a high value of  $Q_{(VPK)}$  and is found having a *Kapha-Pitta* pacifying capacity as explained in the text. The other two combinations are having less value of  $Q_{(VPK)}$  and can be useful for pacifying *Pitta* as evident from the studies. So it is better to consider the *Triphala*-(1:1:1) is the best according to the computational studies with the claimed physiological activity. The *Triphala*-(1:2:4) and *Triphala*-(1:2:3) might also correct as we read and interpret the Sanskrit text correctly as evident from the weight of three to four dry *Embilica officinalis* fruits may approximately equal to the weight of two dried fruits of *Terminalia bellerica* and that of one dry *Terminalia chebula* fruit. This might also be correct if we consider the *Triphala*-(1:2:4) and *Triphala*-(1:2:3) prepared as per the part percentage by number to the correct combination that is equal to the *Triphala*-(1:1:1) by approximate weight itself. Similarly the Drug Efficacy Index of certain folk herbal formulations like *Akashavallitakra* and *Akashavalliksheera* for internal use for the treatment of urinary problems related to Gonorrhoea one of the main sexually transmitted diseases (STD)

and *Akashavallipaste* and *Akashavallitaila* for the treatment of hair loss (a type of *Idralupta*) were also calculated (Table 2).

Table 1: The three combinations of Triphala viz. Triphala-(1:1:1), Triphala-(1:2:3) and Triphala-(1:2:4) and the Drug Efficacy Index Q(VPK) computed for Triphala in different part percentages by weight of the constituents.

Formulation	Constituents	Parts	q <sub>(Vata)</sub>	q <sub>(Pitta)</sub>	q <sub>(Kapha)</sub>	Q <sub>(VPK)</sub>	Pharmacological Nature
Triphala-(1:1:1) (Used weight percentage)	<i>Terminalia chebula</i> (Haritaki)	1	41	-58	-1	0.18	Pacify <i>Kapha-Pitta</i> (कफपित्तघ्नी)
	<i>Terminalia bellerica</i> (Vibhitaki)	1					
	<i>Embilica officinalis</i> (Amalaki)	1					
Triphala-(1:2:3) (Used weight percentage)	<i>Terminalia chebula</i> (Haritaki)	1	45	-54	1	0.08	Pacify <i>Pitta</i> (पित्तघ्नी)
	<i>Terminalia bellerica</i> (Vibhitaki)	2					
	<i>Embilica officinalis</i> (Amalaki)	3					
Triphala-(1:2:4) (Used weight percentage)	<i>Terminalia chebula</i> (Haritaki)	1	45	-52	3	0.04	Pacify <i>Pitta</i> (पित्तघ्नी)
	<i>Terminalia bellerica</i> (Vibhitaki)	2					
	<i>Embilica officinalis</i> (Amalaki)	4					

Table 2: The Drug Efficacy Index of herbal formulations prepared from *Cassythafiliformis* Linn (*Akasavalli*)

Formulation	Constituents	Parts	q <sub>(Vata)</sub>	q <sub>(Pitta)</sub>	q <sub>(Kapha)</sub>	Q <sub>(VPK)</sub>	Pharmacological Nature
<i>Akashavalli</i> Takra-(1:3)	<i>Cassythafiliformis</i> Linn ( <i>Akashavalli</i> )	1	-60	-6	+34	0.32	Pacify <i>Pitta-Vata</i>
	Butter milk	3					
<i>Akasavalliksheera</i> -(1:8)	<i>Cassythafiliformis</i> Linn ( <i>Akashavalli</i> )	1	-14	-43	+43	0.14	Pacify <i>Vata-Pitta</i>
	Cow's Milk	8					
<i>Akashavallitailam</i> -(1:5)	<i>Cassythafiliformis</i> Linn ( <i>Akashavalli</i> )	1	-50	-28	+22	0.56	Pacify <i>Pitta-Vata</i>
	Oil	5					
<i>Akashavalli</i> paste-(100%)	<i>Cassythafiliformis</i> Linn ( <i>Akashavalli</i> )	1	-11	-47	+42	0.16	Pacify <i>Vata-Pitta</i>

According to the *Ayurvedic* principles Gonorrhoea can be considered as a *Vata* disease. The herbal formulations were classified into two different classes according to their pharmacological activity. These formulations can have in two

different states of the Gonorrhoea where the first is useful for treating a *Pitta-Vata* disease and the second is useful for treating *Vata-Pitta* diseases. The nature of the diseases has to be diagnosed correctly according to the traditional diagnostic

methods for better results. The interchange of these two formulations might not affect the person very badly as both are complement to each other but surely delay the curing time. The dosage of the *Cassya filiformis* Linn should be determined very carefully as the plant contains toxic alkaloid called loutrotetanine which is neurotoxic in nature at higher doses. The plant is also used for the preparations of two other formulations viz. *Akashavalli* paste and *Akashavallitailam* as a remedy for hair loss in small round like particular shaped with itching. From *Ayurvedic* diagnosis it can be classified into a particular type of *indralupta* due to the *Vata* (~Air born disease due to microbes) disorder where *Pitta* also plays a role. The *Cassya filiformis* Linn have a *Vata-Pitta* pacifying nature with a calculated  $Q_{(VPK)}$  equal to 0.16 and its oil preparation with sesame oil (*tailam*) have a *Pitta-Vata* pacifying nature with a calculated  $Q_{(VPK)}$  equal to 0.56. A combination of these two formulations for external application can be used for treating hair loss a type of *Indralupta* disease that is caused by the microbes spread through the air. The herbal formulations prepared out of *Cassya filiformis* Linn have proven therapeutic effects as evident from herbal practices of many traditional physicians.

### CONCLUSION

The present study implements the method for calculating the Drug Efficacy Index [ $Q_{(VPK)}$ ] for not only the classical formulations but also the proprietary medicines. I believe this new method has its own impact not only on *Ayurvedic* practice but also drug designing and discovery processes. Further researches are going on to give a mathematical explanation for the corrective entity *prabhava*(II) even though it is stated as not the subject matter of discussions (*acintya*) in classical texts. Presently the proprietary and patented medicines of *Ayurveda* do not contain the pharmacological activity in terms of *Tridosha* which is very essential for a traditional practice. This can be easily understood from the individual components of the efficacies. Authorities have to insist the manufactures to clearly indicate the pharmacological activity in terms of the *Tridosha* theory for the real practicing and nurturing of traditional *Ayurveda*. The diagnosis of diseases is well classified by the WHO for modern medical practitioners to classify the disease very effectively while prescribing. I plead the authorities to implement such a system based on *Tridosha* theory which is essential and the very bases of effective diagnosis and practices of traditional *Ayurveda*. Further researches are also going on to achieve fully featured software for the classification of the formulations and to select an apt formulation from a set of formulations that may help the practitioners for prescribing and researchers to do fruitful researches.

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