

Shape and Compound Relationship in Ginseng Quality

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Abstract

The traditional concept of ginseng quality was investigated in relation to historical experiences, traditional quality measure and modern analytical method. The traditional concept appears to be based on the original Korean thought of oneness in life and universe. The outside appearance such as shape and size in traditional quality measure includes the inside quality. Since certain shape and size define specific tissues, cells and biologically active substances in cells the traditional measure will be a map for analytical method to find active principles. Traditional method suggests that the balance among biologically active compounds seems to be more important than the large

amount of one active compound and that the mode of active compounds in ginseng for the homeostasis of human body is the multicomponent to multitarget system. Traditional method strongly suggests the importance of nitrogen compounds, especially soluble protein and heat stable protein for the balance of active principles since nitrogen compounds are more abundant in the central part (xylem-pith) that grows faster than the outer part (cortex-epidermis). The balance of physiologically active principles appears to be meaningful in relation to the difference in traditional use of *Panax* species.

Introduction

Korea ginseng (*Panax ginseng* C.A. Meyer) has long been used for medicinal purpose and thus taken into one quarter of Chinese herbal prescriptions¹⁾. The quality criteria are very strict and complicate in culture and processing, especially for red ginseng. From the selection of fresh ginseng to the processed one there are various steps for sorting the best quality ginseng. The important factors are still shape and size as the name "ginseng" indicates man-shaped root. It is hardly to believe for so called scientifically oriented present generation that the significance of shape or size has anything to do with the medicinal efficacy. Thus the visible genuine root are unbelievable while the invisible compounds are only believable. The easy abandonment of historical experience without scientific consideration is, however, not scientific since the traditional quality measures are based on the experiences from generation to generation.

According to analytical method ginsenosides are considered most important. Only ginsenosides are so extensively studied that ginsenosides are thought to be most important²⁾. The three years survey on the relationship between growth condition and ginsenosides content or pattern similarity, however, revealed that ginsenosides content increased with the adverse conditions. Thus ginsenoside pattern seems to be more meaningful than its content³⁾.

We investigated and found the true meaning of the traditional concept on ginseng quality in relation to quality measures and assessed the modern analytical concept of quality under the light of the traditional concept.

Materials and methods

Assessment of old concept: History of ginseng was reviewed and collated with traditional quality measures that are in practice at present.

Plant samples: Ginsengs were collected from various plantations in Korea and *P. quinquefolius* and *P. notoginseng* were purchased from market. Each part of root was separated for chemical analysis.

Nitrogen compound⁴⁾: Total(TN) or soluble nitrogen (SN) was determined with powder or water extract of ginseng powder by Kjeldahl method and insoluble nitrogen was obtained by subtraction of SN from TN. Soluble protein was determined with trichloroacetic acid(TCA) precipitate of water extract by Lowry method. Water extract was boiled for three hours and centrifuged. TCA-precipitate of supernatant was used for analysis of heat stable protein(HSP) by Lowry method. The content of total free amino acid(TFA) was determined by ninhydrin method with supernatant after TCA precipitation of water extract.

Pattern similarity of ginsenosides(GPS): Simple correlation of ginsenosides between two samples⁵⁾. All data without explanation about samples are from the series of investigations on ginseng quality at ginseng plantations from 1984 to 1987.

Results and discussion

History of ginseng experience: Korea ginseng (*P. ginseng*) was found by the Emperor Osagu, the 4th emperor of Dan dynasty⁶⁾. The record was shown in Fig. 1. It reads as follow. "The Emperor Osagu had a trip to north on October in Gapsin(BC 2137) and returned to the Great White Mountain, pray the three devines and obtained miraculous plant that was called ginseng or supernatural hermit's medicine. After that the story of immortality of supernatural hermit have had a close relation to digging ginseng for energy. Sometimes person

四世檀君烏斯丘 在位三十八年
甲申元年封皇弟烏斯達爲蒙古里汗或曰今蒙古族爲其後云冬十月
北巡而回到太白山祭三神得靈草是謂人蔘又稱仙藥自後神仙不死
之說與採蔘保精密有關聯間有採得家所傳神異顯靈頗多奇驗云
戊子五年鑄圓孔貝錢秋八月夏人來獻方物求神書而去十月朝野別
記書于石以公于民
庚寅七年設造船于薩水之上
壬寅十九年夏主相失德帝命息達率藍眞弁 三部之兵往征之天下聞之
乃服
辛酉三十八年六月帝崩羊加丘乙立

Figure 1. Record of finding ginseng (BC 2137)

who had taken ginseng said that it was miraculous and supernatural in efficacy as curious experience."

This record will be a strong evidence for long history of ginseng use by Korean ancestors. But actual use of ginseng by human beings may be much longer than this record and thus likely be prehistoric. Ginseng has been meaning the man-shaped white root at least for four thousand years but such opinion began to change by Mr. Garriques in 1834¹⁾. He wanted ginseng to be an active compound. Most of us now, however, only like analytical recognition simply because we are oriented in such a way as scientific. Visible intact root is unbelievable while invisible compounds is only believable. Curiously enough the name ginseng is still alive in the scientific name. Figure 2 shows the comparison of scientific name and the opening motto of new era of Dan dynasty.

The scientific name is very close to the meaning of the motto of new era. Ginseng plants are working for broad benefit in the way of health keeping. The similarity of both name and motto seems not to be a mere chance but it is a historical coincidence since ginseng was found in the early stage of Dan dynasty. The meaning of man-shape is still effective as it appears in scientific name.

<u>PAN</u>	<u>AX</u>	<u>GIN</u>	<u>SENG</u>
凡	藥	人	蔘
弘	益	人	間
—	—	—	—
Wide	Benefit	for	Human

(Idea of New Era)
(Dan Gun Wang Geom BC2333)

Fig. 2. Relationship between the idea of new era of Dan Dynasty and scientific name of ginseng.

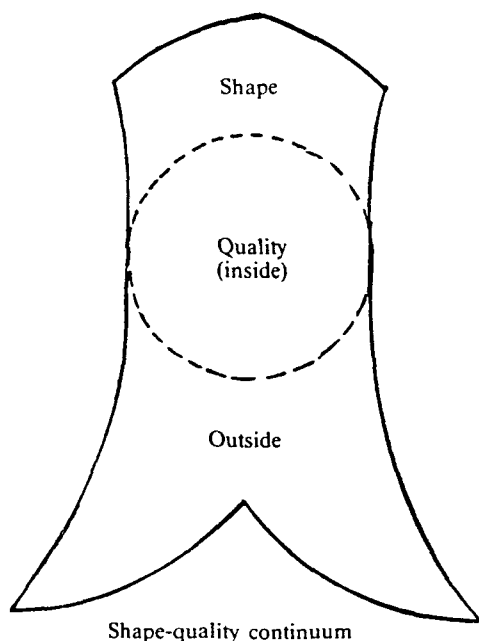


Fig. 3. The definition of shape in the traditional quality concept.

Dr. A.R. Harding visited Korea in 1905 and found that ginseng resembling human body was very high in price⁶⁾. He thought a belief among the Chinese people that ginseng root, especially if of peculiar shape, will cure practically all diseases of mind and body, is superstition. He considered Korean culture as a part of Chinese culture. He was a medical doctor and consequently oriented by analytical way. But he should be more analytical. He could not analyze the way of oriental thought. As he pointed out the Orient see the disease of mind which is in the deep inside of body when they see the disease of body. Thus you must cure the mind first before you cure the disease of body. A visible condition of body includes a invisible condition of inside mind. In the same way of thought the shape of ginseng as a quality does not merely mean an outside status but indicate inside of quality as shown in Figure 3.

The shape means their experience of inside quality factor. If Dr. Harding had given more attention to the way of Oriental thought he would not think the respect of ginseng shape as a superstition. The Orient consider a thing as continuum of inside quality and outside shape as shown in Figure 3. They express the inside quality with various shapes. It may be the only way when they have no separation method of quality factor.

Relation between the old and present concept of ginseng: Now the definition of ginseng is changing according to the view of the Occident. When the ginseng is powdered for the extract the shape of ginseng as a whole is completely neglected since the extract holds all active ingredients. When extract is subjected to fractionation with various solvents for compounds the extract is neglected since you get active compounds. Now ginseng does not mean a root as a whole but a mixture of about 20 ginsenosides²⁾. The saponin content is a quality criterion of ginseng. The difference between old and new concepts of ginseng is well expressed in Figure 4. In the old concept ginseng is a wholesome package containing various active factors that are interrelated while in the modern concept there is a unique compound in ginseng. The relation between chemical compound and physiological target is multicomponent to multitarget in the old concept but single compound to single target in the new concept¹⁾.

The balance among compounds is important for the former while the amount of compound is important for the latter. The fact that the content of total saponin is the quality criterion at present is due to that quality concept is based on new concept, the analytical method. According to the old concept the ginsenoside pattern is more important than the amount of total ginsenosides. The ginsenosides pattern is an index of balance among ginsenosides.

Concept	<u>Old</u>	<u>Modern</u>
Mode :	Multifactors -multitarget	Single Compound -single target
Method :	Experience	Analysis
Criteria :	Age Shape (size)	Compounds (molecules)

Fig. 4. Comparison of ginseng quality concepts.

The balance of active compounds: The importance of shape as a quality criterion of ginseng can be proved by the balance of active compounds. When you take ginseng you take all compounds in ginseng. When you take a ginsenoside nobody can say you take ginseng. For example two ginsenosides that cause hemolysis of red blood cell separately, can not cause hemolysis in mixture⁹⁾. This phenomenon could be an example for the importance of the balance of compounds. When you take single ginsenoside it is out of present discussion since it is not ginseng.

Ginsenosides content is much higher in the fine root or the lateral root than in the tap root but pattern similarity of a part to tap root decreases with the distance of the part from the tap root, the connection order (Table 1). The traditional method to keep manshape for red ginseng by trimming lower part of lateral root and by cutting all fine roots seems to be for the balance of ginsenosides with the decrease of amount¹⁾. The pattern similarity of ginsenosides(GPS) of Korea red ginseng (good grade) is very close for 10 years as shown in Table 2.

Saponin content varies from 2.34% to 2.53% with CV 2.43%. Korea ginseng(red) produced in Japan holds all lateral and fine roots probably due to the thought of importance of saponin content since Japan depends more on analytical method. Korea ginseng (red) produced in China follows the traditional method.

The reason of difference in the content and pattern of ginsenosides in each part of ginseng is due to the difference in tissues of each part. Since specific cell in specific tissue with specific age at special time of season should have certain amount and pattern of ginsenosides, the pattern and amount of ginsenosides of calli were quite different from those of normal root⁹⁾. The shape and size of ginseng root define the size and ratio of each part of root. In such condition the kinds and the

Table 1. Ginsenosides content(GC) and its pattern similarity(GPS) to the main root

Part	Tap root			Lateral root	Fine root	Rhizome
	Pith xylem	Cortex phloem	Epidermis			
Connection order	0	0	0	1	2	1
GC(% dw)	1.02	2.70	7.60	3.94	8.31	6.06
GPS(r)	0.964	0.979	0.730	0.880	0.758	0.896
(p)	0.001	0.001	0.05	0.01	0.05	0.01

r : simple correlation coefficient, P : significance in probability

Table 2. Yearly variation of ginsenosides content(GC) and pattern similarity(GPS) in Korea red ginseng.

Year	4319	4318	4317	4316	4315	4314	4313	4312	4311	4310
GC(% dw)	2.53	2.43	2.47	2.51	2.46	2.53	2.48	2.42	2.34	2.41
GSP(r)	1.0000*	0.9992*	0.9988*	0.9993*	0.9993*	0.9999*	0.9992*	0.9999*	0.9995*	0.9996*
PT/PD	0.877	0.855	0.848	0.848	0.855	0.840	0.826	0.826	0.820	0.833

* significant at P=0.001 year 4319 Dangi is AD 1986

r : correlation coefficient

PT/PD : The ratio of protopanaxatriol saponin to diol saponin

number of tissues in each kind are decided. In the same mode the tissues define cells and the cells define chemical compounds as shown in Figure 5. The overall result is that certain shape and size have the definite pattern of chemical compounds.

The fact that the GPS of rootlet which differentiated from calli was higher with normal root than with calli¹⁾ strongly indicates the definite relationship between shape and compound. In such a view point the substitution of cultured calli for ginseng simply based on the amount of ginsenosides seems to be wrong. All the old control measures are based on visible factors such as shape and size. When the visible factors are different the invisible components are also different.

GPS seems to more meaningful than GC among *Panax* species¹⁾. When *P. ginseng* and *P. quinquefolius* were grown and GPS was compared the significant GPS was shown between the lateral root of *P. ginseng* and tap root of *P. quinquefolius*(Table 3). Such difference seems to be closely related with the different use of *P. quinquefolius* from *P. ginseng*. It is an interesting point to know when *P. quinquefolius* began to be used for the substitute of the lateral and fine roots of *P. ginseng*.

Shape and nitrogen compounds: When ginseng roots grow the growth of root diameter depends more on the growth of central part, xylem and pith than that of cortex and epidermis. The ratio of the square of inside radius to the square of root radius showed highly significant positive correlation with root radius (Table 4) indicating that growth rate of xylem pith(XP) is greater than that of the outer part(CE). When the radius is 16.2mm the volume of the inner part equals to the volume of the outer part as shown in Fig. 6. The ratio of the weight of XP to that of CE also showed significant correlation with root radius (Table 4). The each part has its own physiological function and the chemical constituents are different. Since the saponin may need for protective role

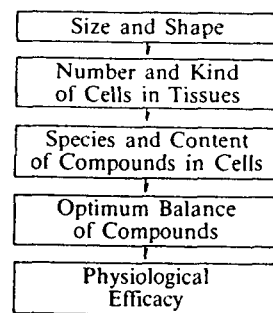


Fig. 5. Relationship between Shape and Compounds.

Table 3. Ginsenosides pattern similarity in various parts of root between *P. ginseng* and *P. quinquefolius* grown under different light intensity.

	Tap root without epidermis	Xylem-pith	Cortex-Phloem	Whole root	Lateral and fine root	Lateral+fine (P.g)-Tap(P.q)	Later(P.g)-Tap(P.q)	Fine(P.g)-Tap(P.q)
P.g 5%-P.q 5%	0.241	0.153	0.263	0.782	0.850*	0.804	0.912**	0.708
P.g 5%-P.q 15%	0.340	0.198	0.447	0.832*	0.812*	0.744	0.890**	0.634
P.g 5%-P.q 30%	0.273	0.160	0.344	0.801	0.796	0.776	0.888**	0.679

n=5 P.g : *ginseng* P.q : *quinquefolius* % : relative growth light
 **, *; Significant at p=0.05 and 0.1

Table 4. Correlation between root characteristics

	ri	ro	ri ² /r ²	L	wi/wo	wt
r	0.980****	0.721****	0.549***	0.067	0.382**	0.751****
wt	0.743****	0.517***	0.463**	0.109	0.616****	

n=29. ****, ***, **, *; p=0.001, 0.01, 0.05
 ri, ro : root radius of xylem-pith, cortex-epidermis respectively.
 wt, wo, wi : weight of total root, cortex-epidermis, and xylem-pith respectively.
 L=length of tap root. r=ri+ro

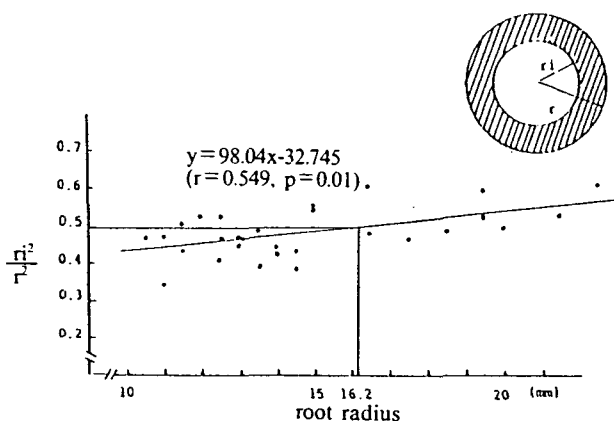


Fig. 6. Relationship between the ratio of root inside radius(ri) to radius(r) and the root radius in ginseng root.

and its content is higher in the CE (Table 1), the greater the root size the lower the saponin content in the root.

In contrast to saponin the content of nitrogen compound is higher in the XP than in the CE as shown in Table 5. The difference in nitrogen content between XP and CE is much distinguishable in *P. ginseng* than *P. quinquefolius*. In *P. notoginseng* total nitrogen content is higher in the outer rind due to the high insoluble nitrogen but soluble nitrogen content follows the same pattern of other species.

The soluble nitrogen compounds mostly consist of soluble protein and free amino acids (small peptides are included). The content of soluble protein (SP) and free amino acid(FA) are higher in XP than in CE in all species with the exception of FA in *P. notoginseng* as shown in Figure 7. Heat stable protein content(HSP) of soluble protein follows the same trend of SP (Fig. 7). Certain fraction of HSP was reported to have radiation protective function¹⁰. Since the radiation protective mechanism includes the protection from free radicals the same nitrogen compounds may have a role to retard senescence. Ginseng has long been called as the Never-old Drug. Okuda reported small molecular peptide having hormone-like activity¹¹.

The research on nitrogen compounds in ginseng is very limited. Recent molecular studies of nitrogen compound are alkaloids¹². Since ginseng has been used as decoction the water soluble protein and small molecular peptides are abundant in extract and appear to be very important for physiological function of human. Soluble nitrogen compounds are also very important for ginseng itself, especially for growth. As mentioned above the growth rate is greater in the central part in which soluble nitrogen content is higher. Thus root weight

Table 5. The contents of various nitrogen forms in various parts of root in *Panax* species.

	<i>P. ginseng</i>					<i>P. quinquefolius</i>		<i>P. notoginseng</i>	
	Tap-root		Lateral-root	Fine-root	Callus	Tap-root		Tap-root	
	X-P	C-E				X-P	C-E	X-P	C-E
Total N.	27.0	18.6	23.6	22.2	43.6	14.8	11.2	11.6	12.3
Insol. N.	2.78	5.70	4.58	7.46	13.4	3.84	4.28	3.78	4.74
Sol. N.	23.0	10.3	16.7	13.5	23.9	8.88	6.22	7.92	7.58
Protein N.	4.68	2.08	3.72	2.48	1.82	1.54	0.14	2.08	1.54
Free amino acid N.	15.9	8.72	13.0	9.94	15.9	7.58	5.66	5.56	5.94

X-P : xylem + pith, C-E : cortex + epidermis

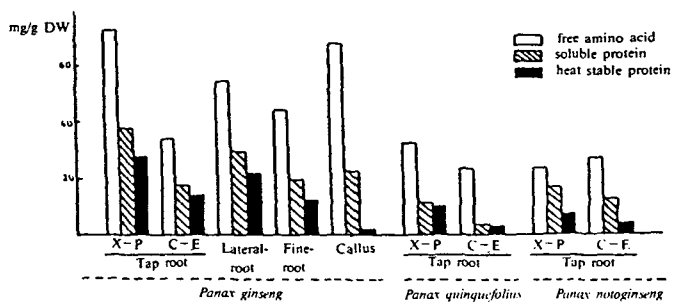


Fig. 7. Contents of nitrogen compounds in various parts of root in *Panax* species. X-P; xylem+pith. C-E:cortex+epidermis.

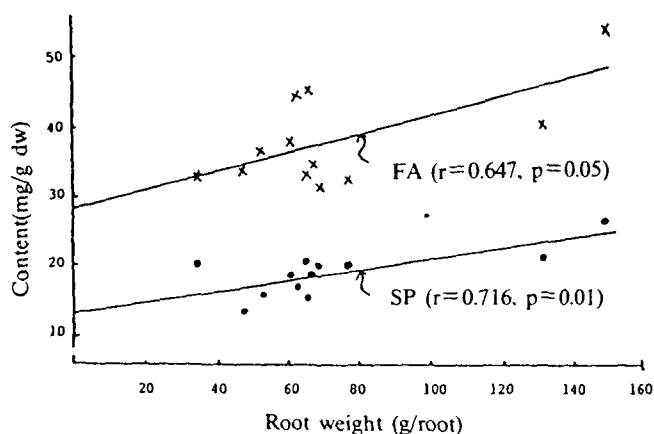


Fig. 8. Relationship between root weight and soluble protein(SP) and free amino acids(FA).

showed significant positive correlation with SP or FA content in root as shown in Figure 8. Furthermore the SP of central part also increases with the increase of root size. The SP may have important role for root growth. In ginseng the greater the size the more abundant the physiologically active nitrogen compound.

In the case of callus culture as shown in Table 4 and Figure 7 the pattern of nitrogen compounds are quite different from ordinarily grown root. Insoluble nitrogen content is very high and in soluble nitrogen fraction FA is about 8 times of SP in comparison with 4 times in the normal roots. Heat stable protein content is extremely low. It is simply because calli are quite different in shape from the normal roots. Therefore the tissue and cells are quite different, and consequently the chemical composition must be different. Without comparing all chemical components it is not scientific to use calli for normal ginseng root.

The use of calli only with total saponin content is the misuse of analytical concept. The conclusion by analytical method must be obtained by the precise analyses in chemical and clinical aspect. According to content and pattern of saponin and nitrogen compounds as shown above the shape and size define chemical composition through certain combination of specified cells in specified tissues as shown in Fig 5.

Therefore the traditional quality measure in which the shape and size are considered being important factors defines the parts in which the biologically active compounds exist. The traditional method is the essential

road map for analytical method where it should go.

Child-Ginseng Legend: A legend about one thing sometimes gives an important clue to understand that thing. We have number of legends about ginseng as it is for tiger. This fact strongly indicates that ginseng has long been deeply involved ancestor's every day life.

The most famous one is the Child-ginseng legend. Mr. Kim's father had long been in illness. There was no way for Mr. Kim and his wife to help father. Mr. Kim's wife prayed for one hundred days to mountain diety and received the revelation between asleep and awake that the decoction of her only child would save father-in-law. She told her husband the diety's guidance and they decided to follow the guidance because they could get son again but never to get father again after he died. Her son came from the village school for lunch. She took her son into the big iron pot in which water was boiling and covered with the iron lid. Soon after her crying her son came in again. They thought it might be an illusion. They opened the iron lid and found Child-ginseng. Their father lived long in good health.

This legend suggests two important thoughts of our ancestors, the faith to move heaven and the filial piety. These two thoughts are based on the same way that they consider the ginseng as one package as a whole. The life of father, son and grandson is the oneness and again man and heaven are the oneness. They can not separate man and heaven as they can not separate the outside shape and the inside quality of ginseng. This thought of oneness is the basic concept to understand the objects. The traditional way of treatment of disease is also based on this thought therefore sometimes they treats other part rather than trouble part.

This Child-ginseng legend suggests three important factors for curative power of ginseng. These are to be man-shaped, supersized and pureness. The child is the symbol of pureness. The traditional quality measure is quite coincident with the suggestion of the old legend.

Someone may consider mother's act in the legend as savage but young sons were killed in mass on the battle field in this century too. Mother's act was for fighting against disease under the name of filial piety but father's act was for fighting against other fathers under the name of patriotism. The latter seems to be more savage. Fathers can send sons to battle fields because they hope "my son could survive". We are likely to think the new as the better.

Conclusion

Strict traditional quality measure of Korea ginseng in which shape, size and age et al. are important factors, is no more superstition. The basic concept of traditional method is well in accordance with the unique philosophy of the Korean that is the oneness, the continuum of all objects in a category. Since the outside shape in the traditional method indicates the inside quality factors the shape defined by the old method as a quality factor must define active compounds, especially the balance among them. Thus the analytical method should refer to the old method for the shortcut to biologically active principles.

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Ara Der Marderosian : Dr. Park. You have shown that the fine rootlets of ginseng are high in ginsenosides. Why are these not used in prepared Korean ginseng products? What is done with rootlets in commercial products? Why are these removed?

H. Park : We use fine root too. But we do not include it in red ginseng. In white ginseng commercial products, fine roots are used all together with main root in some cases. Large amount of fine roots exported. I think fine roots are used in different ways from main body for Chinese medication. I think you seem to confuse traditional red ginseng from newly developed commercial products. My presentation was all about why the fine roots are removed in traditional quality control measure.

인삼품질에 있어 체형과 화합물과의 관계

박 훈, 이 미경, 조 병구

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인삼품질에 대한 전통개념을 역사적 경험, 전통적 품질관리방법 및 분석적 방법과 관련하여 조사하였다. 전통개념은 생명과 우주가 하나라는 한국의 기본사상에 근거한 것으로 보인다. 전통품질관리법에서 모양과 크기와 같은 외부형태는 내부의 품질을 포함한다. 일정한 형상과 크기는 특정한 조직, 세포 및 세포내의 생리적 활성물질을 규정하기 때문에 전통품질관리법은 분석방법이 활성물질을 찾아가는 지도가 될 것이다. 전통법은 생물활성 물질간의 균형이 한 물질의 함량보다 중요하며 인체의 항상성을 위한 활성물질의 작용양식도 여러 화합물, 여러 목표체제인 것으로 보인다. 인삼이 클 수록 중심부가 더 빨리 크고 중심부에는 질소화합물이 많기 때문에 전통법은 질소 화합물 특히, 수용성 단백질과 열안정단백질들이 활성물질의 균형에 있어 중요함을 강력히 시사한다. 생물활성물질의 균형은 삼숙의 중간 전통적 사용방법의 차이와 의미있게 관계를 보인다.