Improved Liver Function Effect Analysis of Drinking the Lacquer Beverage Using Speech Signal Analysis

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Abstract

The extension of healthy life expectancy as well as average life expectancy in modern societies has become a very important social issue. In particular, functional foods rather than medicines for extending the healthy life is becoming a very important issue. For this, in this paper, we will study the efficiency of drinking the lacquer beverage which is a kind of functional foods that help to improve liver function using speech signal analysis. Usually, molar pronunciation becomes clumsily according to Korean Oriental Medicine diagnosis theory if the liver function is improved. Therefore, we will investigate the change of 3 formant frequency bandwidth which is associated with a molar pronunciation through the drinking of the lacquer beverage before and after. Finally, the effectiveness of this research is demonstrated by several experiments.

Keywords: Lacquer Beverage, Speech Signal Analysis, 3 Formants Frequency Bandwidth, Liver Function, Modal Pronunciation

1. Introduction

Korean's basic emotional background is human affection. That alcohol is important as a link in the social life of human relationships. One or two glasses drinking of alcohol is the usually life per every meetings, the various meetings and events consist of heavy drinking and drinking binge. In 100- year- old living, a lot of people are increasing an interest that health and longevity through diet and functional foods. Especially, focused attention about liver with a strain of frequent drinking are increasing. So, in this paper, we will carry out an experiment with lacquer which is especially effective of liver function, relieving of hangover, anti-cancer, stomach, and blood circulation [1, 2]. Therefore, we carried out research by analysis of a voice to determine efficacy of lacquer beverage. For this, we analyzed the third formant frequency bandwidth in the voice analysis elements by lacquer beverage drinking before and after. The third formant frequency bandwidth is associated with liver function from the point of view of Oriental Medicine [3, 4]. Finally, we will demonstrate the efficiency of the our experimental method by several experiments.

2. Efficacy of Lacquer Ingredients and Phonetic Diagnosis Theory

2.1. Lacquer Ingredients and Efficacy

Lacquer is classified into lacquer tree, Also, we can get the lacquer sap by obtaining cutting lacquer trees. There is urushiol and flavonoids ingredients in lacquer, it is efficacy improvement of digestive function and extravasated blood, anti-cancer effects, anti-aging and detoxification of liver in action of anitioxidant. The lacquer's main ingredient is urushiol which is initially colorless but turned black by oxidizing enzyme in contact with air. The urushiol has high hardness and beautiful gloss, Taken lacquer does not change the long-term storage under the acid or alkali or more than heat of 70°C.

Usually, lacquer is used several paint equipment, machinery and wood glue by a mixture of pigment and other color elements using the advantage of these characteristics [5]. Also, lacquer is a good efficacy in treatment of cancer and incurable diseases than wild ginseng. The lacquer destroys the tubercle bacillus in the lung and turns digestive medicine in the stomach. More over, it is great for the skin disease, neuralgia and arthritis drugs [6]. In the Oriental Medicine, it is efficacy to remove bacteria, quench thirst, improvement of digestive function and extravasated blood, anti-cancer effects, anti-aging, and detoxification of liver. In addition, lacquer can be used neuralgia, arthritis, gastrointestinal care, pleurisy, osteomyelitis, and all kinds of cancer by warming up the body. Recently, there is anticarcinogenic substance in the sap of the lacquer which hamper growth cancer cells of lung and stomach [7-9]. According to the book 'myeongui-byeolrok(which means documents of distinguished doctors)', lacquer destroys roundworm, improvement of backache as trouble of digestive organs, stopping the cough[5].

2.1. Relations of Liver and Phonetics

The internal organs in the central of on the human body is the five internal organs (heart, liver, spleen, lungs and kidneys) in the Korean Oriental Medicine. When we treat a diseases based on the Korean Oriental Medicine, status of the five internal organs must be observed through the judgement logic of the five parameters[10]. The diagnostic methods of Korean Oriental Medicine can be divided into consultation and diagnosis. The consultation is the process of collecting the individual symptom of patients, the diagnosis is to determine the direction of the track and treatment the cause of the disease as significance information through consultation. There are four kinds of major consultation method; visual inspection. a medical examination by interview, auscultation and pulse diagnosis. Especially, among these of four kinds of major consultation method, auscultation is a way to examine the disease from the sound and smell of a strange change a patients. It examine patient's speech, breathing or coughing in auditory sense, smell of excrement as subjective judgment of diagnostician [3, 11]. In Korean Oriental Medicine, Gak-sound links with liver function as sound of ㄱ(giyeok). Gak-sound is pronounced by a lips both sides of the canine tooth as velar sounds. If liver function happens a problem, velar sounds listens trouble, This is a criterion about a liver diseases[12].

In this paper, we analyze the voice signal to extract correlation of liver function and voice by lacquer beverage drinking before and after based on the Korean Oriental Medicine, Also, we derived correlation of the five internal organs and the five sounds by measuring the change resonance cavity and vocalization. Thus, we carried out voice analysis of velar sounds by applying the same method of Korean Oriental Medicine. Table 1 shows the five phase elements associated the five internal organs below in. As we know in Table 1. The liver corresponds with Gak-sound of a pentatonic scale and its sound is velar sounds [13, 14].

Table 1. The List of Five Phase Parameters

the Five Elements	wood	fire	earth	metal	water
the Five Internal Organs	liver	heart	spleen	lungs	kidneys
Number of Sounds	1,2 stroke	3,4 stroke	5,6 stroke	7,8 stroke	9,10 stroke
Sounds	ㄱ,ㅋ (giyeok, kieuk)	ㄴ,ㄷ,ㄹ,ㅌ (nieun, digeud, rieul, tieut)	ㅇ,ㅎ (ieung, hieud)	ㅅ,ㅈ,ㅊ (sieud, jieud, chieud)	ㅁ,ㅂ,ㅍ (mieum, bieub, pieub)
Pronunciation	velar sounds	lingual sound	guttural sound	dental sound	labial sound
Pentatonic Scale	Gak	Chi	Gung	Sang	Woo

3. Application of Speech Analysis Parameter

In this paper, to measure voice change in drinking of lacquer beverage before and after, we carried out an experiment to apply the third formant frequency bandwidth in the voice analysis elements. There is vocal track like tube in inside the human body. When air pass vocal track tube, sound and terminal (vocal cords, tongue, tooth, lips) generate final sounds and vocal track such like this is called Formant. Also, generated waveform so like this is bandwidth of formant frequency. The formant frequency can be extracted by using LPC of voice signals. LPC can be predicted a linear combination with output signal of the current and the input signal of the past [15, 17]. This is showing good performance accuracy and computational speed, its associated with a voice production model can be expressed fewer parameters with features of voice. In other words, the voice of a certain interval divided by the N pieces voice samples s(1), ..., s (N) of one point in the voice signals (n), a constant section M (M <N) pieces of one sample are divided by the signals (n-1), ..., s(nM) which can be expressed by the following formula:

$$s(n) = \sum_{i=1}^{M} a_i s(n-i) + e(n) \quad M+1 \le n \le N \tag{1}$$

$$s(n) = \sum_{i=1}^{M} a_i s(n-i) + e(n) \quad M+1 \le n \le N \tag{2}$$

The above formula (1) and (2), s(n) is the voice signal, ai are the prediction coefficients, M is prediction degree and e(n) means prediction error. In this paper, we can be extracted all candidates of formant frequency and bandwidth to compute A(z), root of inverse filter obtain formant frequency values using value of LPC, bandwidth B and F complex about z of complex roots means z-periodicity in the plane T from s-plane to z-plane for change[18, 19].

$$F = (\frac{f_s}{2\pi})\tan^{-1}[\frac{I_m(z)}{R_e(z)}] \tag{3}$$

$$B = -(\frac{f_s}{\pi})\ln|z| \tag{4}$$

In this paper, we was performed voice analysis by using the voice analysis program Praat. Also, the measured parameter of formants is set up a time corresponding to 25% of analysis window length in Praat, The number of formants is set up the fourth formants. Maximum formant configures 4,000 Hz. because of the average value is a 1,000 Hz in every formants.

Window length which dominates the analyzed voice range is set up a Gaussian method. Finally, Pre-emphasis is a high-pass filter which extracts the most clear formants value if we use 50 Hz. If we use 100Hz is amplified 6dB and 200Hz is amplified 12dB [15, 20, 21].

4. Experiments and Analysis

4.1. Experiments and Results

In this paper, we assured correlation of liver function and voice based on the Korean Oriental Medicine theory for verifying the efficiency of lacquer beverage. For this, we developed the efficiency verification method through the voice analysis of lacquer beverage intake before and after. Proposed experimental method which measures the resonance cavity and vocalization change of lacquer beverage intake before and after based on the Korean Oriental Medicine theory that is a diagnosis theory by correlating the five internal organs, pentatonic scale and the five sounds. To analyze correlation of liver function and voice, we analyzed change of voice after drinking 150ml of lacquer beverage for four days in the same time.

Firstly, we selected the 20 healthy men and 20 women as subjects. In order to obtain accurate voice data, of lacquer beverage intake before and after using the same equipment, we recorded the voice by maintaining a distance of 10cm in hermetically sealed space. We use the sentence as recording voice 'gakkai saneun gakkakkineun ko kkili wa katda)' that sentence is a velar sounds(giyeok, kieuk, kkiyeok) associated with liver function.

Table 2. The List of the Third Formant Frequency Bandwidth According to the Drinking Lacquer Beverage on Male of 20s

Male	Before experiment	First Day	Second Day	Third Day	Fourth Day
M01	695.580	409.461	393.293	318.311	292.832
M02	780.450	367.128	407.483	409.605	298.430
M03	632.104	492.341	399.937	275.159	165.966
M04	534.544	258.708	374.691	354.788	313.698
M05	475.378	221.806	129.725	391.771	220.814
M06	608.927	369.567	191.938	158.466	262.240
M07	555.071	441.949	364.633	277.806	183.831
M08	567.990	511.126	400.782	300.346	366.633
M09	624.529	453.363	230.911	135.378	313.752
M10	771.021	333.490	281.480	184.380	240.385
M11	584.369	457.451	371.693	226.881	161.447
M12	538.321	300.896	182.047	375.106	302.552
M13	624.523	513.206	439.594	356.338	298.648

M14	514.920	439.564	425.680	419.674	360.492
M15	636.842	486.992	324.160	276.495	258.490
M16	635.425	504.285	435.774	400.165	335.076
M17	562.758	395.745	402.132	426.325	322.079
M18	498.766	316.246	297.889	215.258	185.965
M19	695.095	431.465	335.253	259.478	221.094
M20	573.938	332.447	230.445	171.224	384.495

Table 3. The List of the Third Formant Fequency Bandwidth According to the Drinking Lacquer Beverage on Female of 20s

| Female	Before Experiment	First Day	Second Day	Third Day	Fourth Day
W01	652.875	312.562	196.221	327.996	282.620
W02	921.071	223.509	514.828	336.839	189.014
W03	793.999	430.093	428.864	411.486	317.442
W04	811.504	695.491	412.913	235.088	210.906
W05	703.118	341.048	444.890	182.060	160.998
W06	602.743	386.267	327.061	160.699	215.806
W07	777.108	424.407	296.693	178.329	106.097
W08	916.200	530.682	308.825	278.332	242.310
W09	678.646	390.126	378.879	284.982	263.328
W10	637.018	236.781	376.394	286.153	203.397
W11	637.485	363.087	217.267	242.346	220.584
W12	648.554	432.485	359.721	178.435	212.320
W13	632.199	473.954	480.452	163.254	192.447
W14	846.486	440.396	108.443	316.924	248.974
W15	683.482	416.178	432.370	164.532	151.629
W16	728.345	562.362	465.864	530.753	448.685
W17	702.684	486.425	415.874	340.256	186.468
W18	615.390	490.120	337.123	413.525	234.186
W19	812.057	631.023	465.743	297.904	195.560
W20	635.482	385.378	397.331	356.741	295.426
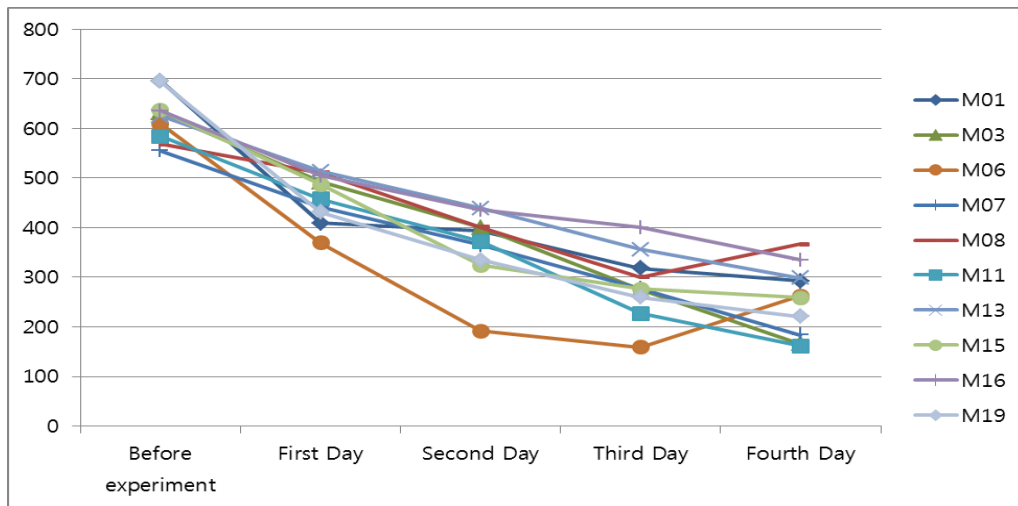
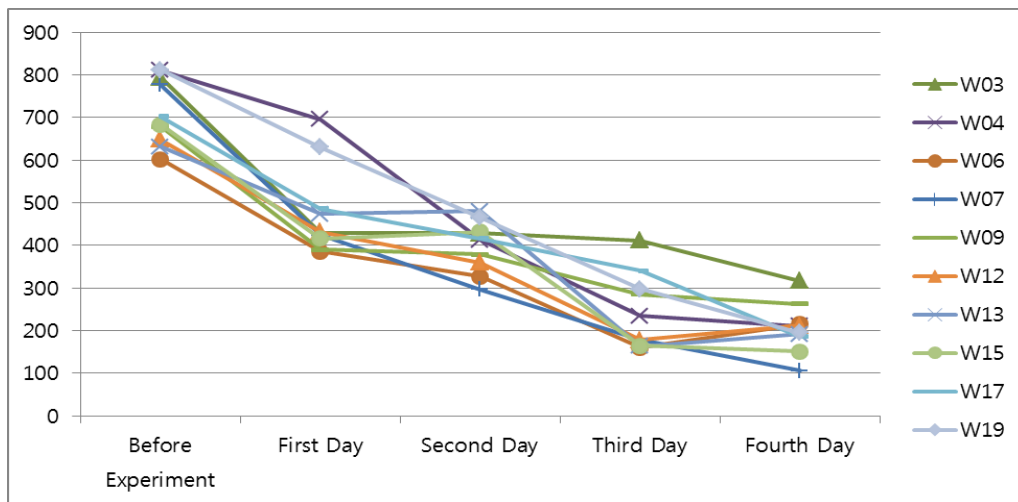**Figure 1. Experimental Results also Change of Male Subjects Group (10 Samples)**

Figure 2. Experimental Results also Change of Female Subjects Group (10 Samples)

According to the experimental results in Table 2 and Table 3, Figure 1 and Figure 2, we can see that the numerical values of third formant frequency bandwidth in all subjects decreased which means the liver function improving of the lacquer beverage is efficient in spite of the decreased value of all subjects are different.

4.2. Statistical Analysis

In this paper, we carried out the analysis of statistical significance about experimental results values for verifying the statistical significance. With this in mind, repeatedly drinking beverage of lacquer ingredient, we took analysis of variance for significant difference in collected voice to apply the third formant frequency bandwidth analysis technique [22, 23]. The collective results of the statistical analysis of male subjects are F = 61.029, p-value 0.000.

This means that significant difference is admitted. In each corresponding comparison, there is significant difference changes in the voice drinking lacquer beverage before and after from the first day to the fourth day. This means that collected voice of drinking lacquer beverage after by applying to analytical technique of the third formant bandwidth is lower significantly than drinking lacquer beverage before. Also, it is significant difference of voice from the first day to the fourth day drinking lacquer beverage after but did not change a significant voice from the second day after drinking. As the more repeated drinking of lacquer beverage, trend of voice is linear trend (F = 141.291, p-value = 0.000), the second (F = 32.680, p-value = 0.000) and third (F = 4.894, p-value = 0.039). We can know the curve effect.

Table 4. Result of Effect Verification in Object of Repeatedly Measured ANOVA Result (Male Group)

Sources	Sum of Squares	the Degree of Freedom	Mean Square	F	p
Objects	1436304.674	4	359076.169	61.029	.000
Margin of Error	447157.899	76	5883.657		

In the similar way, the significant difference of statistical analysis of a group of female subjects is F = 89.611, p-value of 0.000. There is a significant difference of voice change before and after ingestion of lacquer beverage in response-specific comparisons from the first day to the fourth day. This means that collected voice of drinking lacquer beverage after by applying to analytical technique of the third formant bandwidth is lower significantly than drinking lacquer beverage before. Also, it did not change a significant voice from the first day to the second day but shows the significant difference of voice from the third day. The difference between second day and fourth day is significant and also difference between third day and fourth day is significant such as the former case. As the more repeated drinking of lacquer beverage, trend of voice is linear trend (F = 248.669, p-value = 0.000), the second (F = 46.784, p-value = 0.000) and third (F = 9.971, p-value = 0.005). We can know the curve effect such as the male case.

Table 5. Result of Effect Verification in Object of Repeatedly Measured ANOVA Result (Female Group)

Sources	Sum of Squares	the Degree of Freedom	Mean Square	F	p
Objects	2960629.157	4	740157.289	89.611	.000
Margin of Error	627733.709	76	8259.654		

5. Conclusion

According to the increased stress, drinking culture and alcohol consumption, interests of a lot of people concentrate on diet and functional foods for maintaining the healthy states. Usually, the efficacy of the lacquer is hangover, anti-cancer effects, and the blood circulation. Especially, the lacquer ingredient is known to efficacy of liver function improving. For this, in this paper, we applied voice analysis for efficiency verification the drinking of lacquer beverage before and after, based on the Korean Oriental Medicine. We studied by applying to

voice analysis elements of the third formant frequency bandwidth which associated with liver function of human organs. As experimental results, we can see the decreased value of the third formant frequency bandwidth of all subjects. Since the sound associated with the liver is velar sound in theory of Korean Oriental Medicine, the experimental results means the drinking of lacquer beverage is effective temporarily in improving the liver function. In the further study, we will analyze clearly the correlation of liver function efficiency and lacquer beverage drinking in project of long time and as a results, we can draw better result of significance and reliability.

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