Effects of Blueberry, *Vaccinium corymbosum*, on the Eye Functions

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Bilberry, *Vaccinium myrtillus*, has been reported to improve night vision. Some clinical trials have shown the positive effects of bilberry on improving the eye functions while other studies did not. Blueberry, *Vaccinium corymbosum*, is a berry related to the bilberry. Many Japanese people are unable to distinguish bilberry from blueberry and therefore imagine that blueberry, too, must have a good effect on the eye functions. However, there have so far been few reliable scientific trials made on the blueberry. The objective of this study was to evaluate the effects of the blueberry on eye functions in humans. Seven healthy volunteers consumed 10 g of dried blueberry. Four hours later, all 7 demonstrated no improvement in their dark adaptation, visual field, tearing by Schirmer-1 test, blinking, or subjective symptoms. Another healthy 10 volunteers took 7 g of dried blueberry for 21 days. However, again no improvement was observed in their dark adaptation, visual field, tearing, blinking, or subjective symptoms. As a result, we could not find any clear proof that blueberries actually improve the eye functions, including night vision and dry eye, in humans, based on the findings of the above 17 subjects.

**Key words**: anthocyanosides, bilberry, blueberry, eye, night vision

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**Introduction**

Bilberry, *Vaccinium myrtillus*, grows on a shrubby plant in Europe and North America. Europeans have used the bilberry fruit for many years to make jams and jellies. The notion that bilberry can be used to enhance night vision arose from anecdotal reports of British Royal Air Force aviators in World War II eating bilberry jam to improve their night vision1-3. Several studies in Europe have reportedly shown an improvement in night vision after consuming a variety of bilberry supplements in the 1960s, however, few scientific reports on this topic in English are available. In the USA, Muth et al.4 failed to find any improvement in night vision by bilberry supplementation. As a result, some trials have shown positive effects while others did not5-11.

Blueberry, *Vaccinium corymbosum*, is a berry related to the bilberry. In Japan, most people are unable to distinguish blueberry from bilberry. Therefore, a lot of Japanese people imagine that blueberry must also be good for the eye functions. Unfortunately the mass media in Japan often make many irresponsible statements regarding blueberries without also providing trustworthy scientific evidence. For example, some commercial books12-13 say that blueberry ameliorates or prevents hypertension, diabetes mellitus,
arteriosclerosis, cancer, and eye functions such as night blindness, mental fatigue of eye, myopia, hyperopia, presbyopia, cataract, glaucoma, retinopathy, myodesopsia, visual field constriction, dry eye syndrome (tearing insufficiency), and so on. However, these authors did not publish such data in any formal scientific journals in the medical field. In addition, very few reliable scientific studies have been made on the blueberry regarding its ability to improve the eye functions. The objective of the present study was to evaluate the effects of blueberry on the human eye functions, namely, dark adaptation, visual field, tearing, blinking, and subjective symptoms.

Methods

Subjects
This study was approved by The Human Research Ethics Committee at Tokyo University of Agriculture. Seventeen healthy female volunteers (21 and 22 years old) were recruited for this study. None of the participants had any ophthalmological diseases except for common myopia (7 persons) and all gave their informed consent. Dried blueberry was purchased from an ordinary food shop in Japan.

Eye functions
Dark adaptation was evaluated according to the method of Newell [16]. Briefly, the period until visualizing various sizes of ten black circles on a white sheet in the dark room was measured. The visual field was evaluated with a perimeter [6,17]. The angles for eight directions were measured with five color targets (black, yellow, blue, red, green) one by one. The mean values of angles obtained in one direction with one target were compared between blueberry consumption and control. Tearing was evaluated using a Schirmer test strip (TORIC, INC, USA) according to the Schirmer-1 test [19]. The blinking rate was also evaluated for one minute. The subjects were asked to answer concerning subjective symptoms, namely, general conditions (stiffness of the neck and shoulder, irritation, headache, and constipation), eye conditions (mental fatigue of eye, itching, and red eye), and face skin conditions, in which the degree was evaluated on graded subjective scales (grades 1-10) [19].

Protocols
Protocol 1: Acute effect (n=7)
We investigated whether a one time ingestion of blueberry improved eye functions. From 1 p.m. the 7 subjects watched an animated movie on a video display terminal for one hour and consumed 10 g dried blueberry. All participants then took a rest for 4 hours, and thereafter the eye functions were evaluated. During the 4-hour rest period, watching TV/video, reading, and eating were all prohibited. Seven days later, the similar experimental protocol was repeated without the ingestion of blueberry (control).

Protocol 2: Chronic effect (n=10)
We investigated whether the ingestion of blueberry for 21 days improved the eye functions. Ten subjects were randomly divided into two groups (5 each). One group (n=5) ingested 7 g of dried blueberry with their breakfast for 21 consecutive days and then had breakfast without blueberry for the next 21 days as a control. Another group (n=5) had a breakfast without blueberry for 21 days as a control and then took 7 g dried blueberry with their breakfast for the next 21 days. On days 21 and 42, the eye functions were evaluated in both groups.

Statistical analysis
All data are presented as the mean values±SD. Differences between the means were assessed by either the paired t-test or Wilcoxon's signed rank sum test. A value of P<0.05 was considered to indicate statistical significance.

Results
Protocol 1: Acute effect (n=7)
The one time ingestion of dried blueberry did not significantly change dark adaptation (437±100 vs 392±123 sec, n=7, paired t-test) or visual fields of 5 colors for 8 directions (n=7 each, paired t-test), in which the upward angles of the sinistral eyes were 29.3±8.9 degrees by blueberry vs 30.0±10.8 degrees in control (n=7) with a black target, 36.4±8.0 vs 35.7±11.0 degrees with a yellow one (n=7), 35.0±7.1 vs 30.7±11.7 degrees with a blue one (n=7), 30.0±8.2 vs 30.0±10.4 degrees with a red one (n=7), and 27.9±8.1 vs 28.6±9.0 degrees with a green one (n=7) and other data of angles (n=7 each) are not shown. Tearing in
the sinistral eyes was significantly reduced by the blueberry (16±11 vs 21±10 mm, P<0.05 paired t-test), whereas that in the dextral did not change (14±9 vs 19±9 mm, paired t-test). The blinking rate (15.0±14.3 vs 23.0±11.3/min) and subjective symptoms (stiffness of the neck and shoulder, irritation, headache, constipation, mental fatigue of eye, itching of eye, red eye, and face skin conditions) did not significantly change after the ingestion of blueberry (data not shown) (paired t-test and Wilcoxon's signed rank sum test, respectively). These results are summarized in Table 1.

Protocol 2: Chronic effect (n=10)

The ingestion of dried blueberry for 21 days did not significantly change dark adaptation (370±96 vs 422±110 sec, n=10, paired t-test), the visual fields (n=10 each, data not shown, paired t-test), tearing (24±10 vs 24±11 mm in the sinistral and 26±10 vs 27±8 mm in the dextral, n=10 each, paired t-test), blinking rate (24.0±6.4 vs 29.0±10.6/min, n=10), or any subjective symptoms (n=10 each, data not shown, Wilcoxon signed rank sum test). These results are summarized in Table 1.

Discussion

We could not find any beneficial effect of blueberry on the eye conditions with an ordinary dose of blueberries taken for short and long durations. Hence, the current study casts doubt on the proposition that blueberry is an effective treatment for improving the eye functions in a human population. A significant difference was only found for tearing in the sinistral eyes in protocol 1 (acute effect). The consumption of blueberries did not increase tearing but instead reduced it. However, the reduction of the tearing is negative phenomenon for dry eye syndrome.

Bilberry has a long history of use for various eye conditions. The active components, flavonoid anthocyanosides, are potent antioxidants with a particular affinity for the eye and vascular tissue. In a clinical study, the combination of bilberry (90 mg anthocyanosides/day) and vitamin E stopped the progression of senile cataract. Bilberry extract (115 mg anthocyanosides/day) has also been shown to improve the symptoms of diabetic retinopathy. However, in another study, bilberry supplementation (120 mg anthocyanosides/day) failed to improve either night visual acuity or contrast sensitivity. Similarly, oral intake (24 mg anthocyanosides/day) of bilberry failed to improve night vision. Other clinical effects of bilberry extract have also been reported, including an improvement in peripheral vascular insufficiency of the foot (480 mg anthocyanosides/day), dysmenorrhea (115 mg anthocyanosides/day), and the platelet aggregating activity (480 mg anthocyanosides/day).

We used dried blueberry which is normally available on the market in this study. Dried fruit has the advantage of being easy to obtain throughout the year while also having a lower cost than fresh fruit.

Table 1  Effects of blueberry

<table>
<thead>
<tr>
<th>Indices</th>
<th>Control</th>
<th>Blueberry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute effects (n=7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dark adaptation</td>
<td>392±123</td>
<td>437±100 sec</td>
</tr>
<tr>
<td>Tearing: sinistral</td>
<td>21±10</td>
<td>16±11* mm</td>
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<tr>
<td></td>
<td>19±9</td>
<td>14±9 mm</td>
</tr>
<tr>
<td>Blinking rate</td>
<td>23.0±11.3</td>
<td>15.0±14.3/min</td>
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<tr>
<td>Chronic effects (n=10)</td>
<td></td>
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<tr>
<td>Dark adaptation</td>
<td>422±110</td>
<td>370±96 sec</td>
</tr>
<tr>
<td>Tearing: sinistral</td>
<td>24±11</td>
<td>24±10 mm</td>
</tr>
<tr>
<td></td>
<td>27±8</td>
<td>26±10 mm</td>
</tr>
<tr>
<td>Blinking rate</td>
<td>29.0±10.6</td>
<td>24.0±6.4/min</td>
</tr>
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</table>

*P<0.05 vs control (paired t-test)
Dried blueberry contained 1,400 mg/100 g of anthocyanosides, whereas dried bilberry contained 2,400 mg/100 g of them. We therefore applied approximately 100 mg anthocyanosides (7 g dried blueberry) which is thought to be suitable doses for supplementation. Since there are various kinds of anthocyanosides and bilberry and blueberry are different species, anthocyanosides in blueberry may therefore have a weaker effect on the eye functions.

We could not find any proof that blueberries actually improved the eye functions. In protocol 2, only 10 subjects were tested and the eye functions of the baseline control in 5 subjects were evaluated on day 42. The number of subjects (n = 10) were not so many and the wash-out period (21 days) might be too short to have wash out blueberry contents completely. Therefore, the present study did not belong to the category of an accurate randomized clinical trial and as a result the sensitivity of the statistical analysis was also low. We used only a total of 17 subjects in the present experiments. This may be the reason why we failed to find a statistically significant difference between the blueberry group and the control one. We should have used a large number of subjects for this study. If we had done so, then the beneficial effect of blueberry might thus have been shown.

In conclusion, we could not find any proof that a normal dose of blueberries induced any improvement in the eye functions in humans, based on the findings of the above 17 subjects.

References

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ブルーベリーの眼機能改善効果

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ブルーベリーは夜間視力を改善することといわれている。しかしこういった臨床試験が試みられているものの、はっきりした結果は出ていない。ブルーベリーはブルーベリーと近縁の植物で、日本ではブルーベリーとしばしば混同されている。従って多くの日本人はブルーベリーが視力改善に効果があると思っているが、ブルーベリーの眼機能に関する研究はほとんどなされていない。本研究ではブルーベリーが眼機能を改善するか否かを調べた。7人の健康成人に10gの乾燥ブルーベリーを摂取させ、4時間後に眼機能を評価した。暗順応時間、視野、流涙量（シルマー試験で評価）、まばたき回数、自覚所見には改善は見られなかった。また、10人の健康成人に毎朝7gの乾燥ブルーベリーを21日間摂取させたところ、やはり暗順応時間、視野、流涙量、まばたき回数、自覚所見には改善は見られなかった。すなわち、今回の17人の被検者で調べた限りでは、一般的摂取量のブルーベリーでは明らかな眼機能改善効果は見い出せなかった。

キーワード：アントシアニン、ブルーベリー、ブルーベリー、視力、目

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