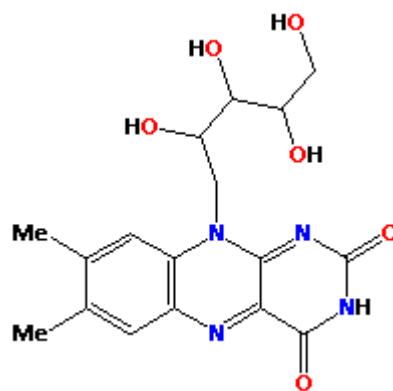


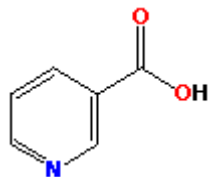
Chez Brivett  
Dr. William Nirode  
Hofstra University  
Aug. 20, 2005  
Research Paper

## Analysis of B Vitamins

### Analysis of B Vitamins in Various Energy Drinks



Vitamin B<sub>2</sub>, C<sub>17</sub>H<sub>20</sub>N<sub>4</sub>O<sub>6</sub>



Vitamin B<sub>3</sub>, C<sub>6</sub>H<sub>5</sub>NO<sub>2</sub>



Vitamin B<sub>6</sub>, C<sub>8</sub>H<sub>11</sub>NO<sub>3</sub>

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## **Analysis of B Vitamins**

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#### **Abstract**

This research primarily involved working with various B vitamins; analyzing them in various energy drinks, and vitamin tablets. We worked with several B vitamins, which are Riboflavin (Vitamin B<sub>2</sub>), Pyridoxine (Vitamin B<sub>6</sub>), Cobalamin (Vitamin B<sub>12</sub>), and Niacin (Vitamin B<sub>3</sub>). These vitamins are very important and essential for human nutrition, and growth, and are available in various foods, but can be found easily in energy drinks, vitamin tablets and other vitamins supplements. These artificial sources are great for people who don't eat certain food that contains these vitamins, or are highly deficient. The deficiency of these vitamins can cause serious damage to our health and appearance. We analysis several energy drinks for the concentration of these vitamins with various methods, including a Uv-Vis scan and a Fluorescence scan.

#### **Introduction**

Vitamins are very essential for the most of the body's functions and are required by the body in small amounts for metabolism, to protect health, and for proper growth in children. Vitamins also aid in the formation of hormones, blood cells, nervous-system chemicals, and genetic material. They generally act as catalysts, combining with proteins to create metabolically active enzymes that in turn produce hundreds of important chemical reactions throughout the body. Without vitamins, many of these reactions would slow down or stop. The thirteen well identified vitamins are classified according to their ability to be absorbed in fat or water. The fat soluble vitamins which, A, D, E, and K, are generally consumed along with fat containing foods, and because they can be stored in the body's fat, they do not have to be consumed every day. The water-soluble vitamins, which are the eight B vitamins and vitamin C, cannot be stored and must be consumed frequently. The body can manufacture only vitamin D; all others must be derived from the diet. Lack of them causes a wide range of metabolic and other problems.

A well balanced diet contains all the necessary vitamins, and most individuals who follow such a diet can correct any previous vitamin deficiencies. However, persons who are on special diets, who are suffering from intestinal disorders that prevent normal

absorption of nutrients, or who are pregnant or lactating may need particular vitamin supplements to boost their metabolism.

Also known as vitamin B complex, B vitamins are fragile, water-soluble substances, several of which are particularly important and are introduced below:

Riboflavin, or vitamin B<sub>2</sub>, serves as a coenzyme—one that must combine with a portion of another enzyme to be effective—in the metabolism of carbohydrates, fats, and, especially, respiratory proteins. It also serves in the maintenance of mucous membranes. Other functions include the elimination of soreness of mouth and lips, also important for good muscle tone, for antibody production, for cell respiration and growth, for good vision, skin, hair and nails and for red blood cell formation. The best sources of riboflavin are liver, milk, eggs, meat, soy products, fish, cheese, dark green vegetables, whole grain and enriched cereals, pasta, bread, legumes, and mushrooms. A lack of riboflavin in the body reduces energy levels. Riboflavin is also needed for the formation of hair, skin, and nails.

Niacin, also known as nicotinic acid and vitamin B<sub>3</sub>, also works as a coenzyme in the release of energy from nutrients. Niacin is useful to prevent symptoms like swollen tongue, diarrhea, mental confusion, irritability, and, when the central nervous system is affected, depression and mental disturbances. The best sources of niacin are liver, poultry, meat, canned tuna and salmon, whole grain and enriched cereals, dried beans and peas, and nuts.

Pyridoxine, or vitamin B<sub>6</sub>, is necessary for the absorption and metabolism of amino acids. It also plays roles in the use of fats in the body and in the formation of red blood cells. Pyridoxine deficiency is characterized by skin disorders, cracks at the mouth corners, smooth tongue, convulsions, dizziness, nausea, anemia, and kidney stones. The best sources of pyridoxine are whole grains, cereals, bread, liver, avocados, spinach, green beans, and bananas.

Cobalamin, or vitamin B<sub>12</sub>, is necessary for the formation of nucleoproteins, proteins, and red blood cells, and for the functioning of the nervous system. Cobalamin is obtained only from animal sources—liver, kidneys, meat, fish, eggs, and milk.

## Overview

These B vitamins; Riboflavin, Niacin, Pyridoxine, and Cobalamin, are present in different concentrations in various energy drinks, some greater than others. To find out the exact concentration of these vitamins in the energy drinks, we run an absorption scan and or a fluorescence scan. Several of the B vitamins doesn't absorb very well, so we had to convert and run a fluorescence scan.

## Materials

- Uv-Vis Spectrometers
- Fluorescence Spectrometer
- Computers
- Microsoft Excel
- Pipets
- Beakers
- Stirrer / Hot plate
- Stir bars
- Volumetric flask
- Cuvettes
- Pure water
- Acidic acid
- Riboflavin Tablets ( Vitamin World, and GNC brand )
- Energy Drinks
  1. Energy Venom
  2. Red Rush
  3. KORE
  4. Mad Croc.
  5. Full Throttle
  6. Stacker 2
- Riboflavin (Sigma Chemical Co.)
- Pyridoxine (Sigma Chemical Co.)
- Cobalamin (Sigma Chemical Co.)
- Niacin (Sigma Chemical Co.)

## Methods

For this procedure to be done, we first create a stock solution (of each of the vitamins), by first:

### Steps

1. Calculating the amount of the substance (the B vitamin) to weight out
  - Multiply the concentration that we want, which is usually  $1 \times 10^{-3}$  M, by the volume of the flask, then by the molecular weight of the vitamin.
2. Then we recorded the exact weight and then add it to a beaker, and add a solvent (which is usually water or acetic acid), set it to stir and wait until it dissolved.
3. Create a stock solution
  - Add the solution in the beaker to a 100 ml Volumetric Flask, and dilute with the same solvent.
4. From that stock solution we then created several dilutions of different concentration, in order to create a calibration curve of each of the vitamins. We ran the dilutions on either UV-vis Spectroscopy or Fluorescence Spectrophotometer machines, which produces a graph so we can see where it absorbs or fluorescence.
5. Then we use the absorption points and or the intensity points on the graphs and entered them into Microsoft Excel to create the calibration curve.
6. After creating the curve, we analyze various energy drinks at various concentrations (ex. 1 ml into a 10 ml flask), place a sample in a cuvette, and then run them on either machines.
7. Running the dilutions on the spectrometers.
  - On the UV-vis Spectroscopy, first we set the wavelength, place a cuvette with pure water into the back place holder then zeroed it.
  - Then put the cuvette with the sample in the front place holder and then start the scan.
  - On the Fluorescence Spectrophotometer, there's only a place holder for the sample, it doesn't use one for the water.
  - First we set up the scan, by choosing various scanning options. We set either an excitation or an emission scan, next we set where to excite, then set the wavelength
  - Next we zeroed the scan, then place the sample inside, then start the scan.
8. Then we entered the absorption and or intensity points on the graph of each of the energy drinks into the equation produced by the calibration curve and do the calculations.

### **Method for preparing the Vitamin tablets stock solution**

1. Weight out 5 tablets, and find the average weight of all five
2. Crush one and weight out .1 grams
3. Add to a beaker with acetic acid, stir until dissolved, then pour into a 250ml volumetric flask, and dilute with the same solvent.
4. Then follow the procedure from step 6-8 above

## Results

Several of the B vitamins, which include Riboflavin, Niacin, and Pyridoxine, were detected in the energy drinks, but Cobalamin was hardly detectable because of its low concentration in these drinks.

Intensity points of each of the energy drinks with the B vitamins, respectfully

**Table # 1**

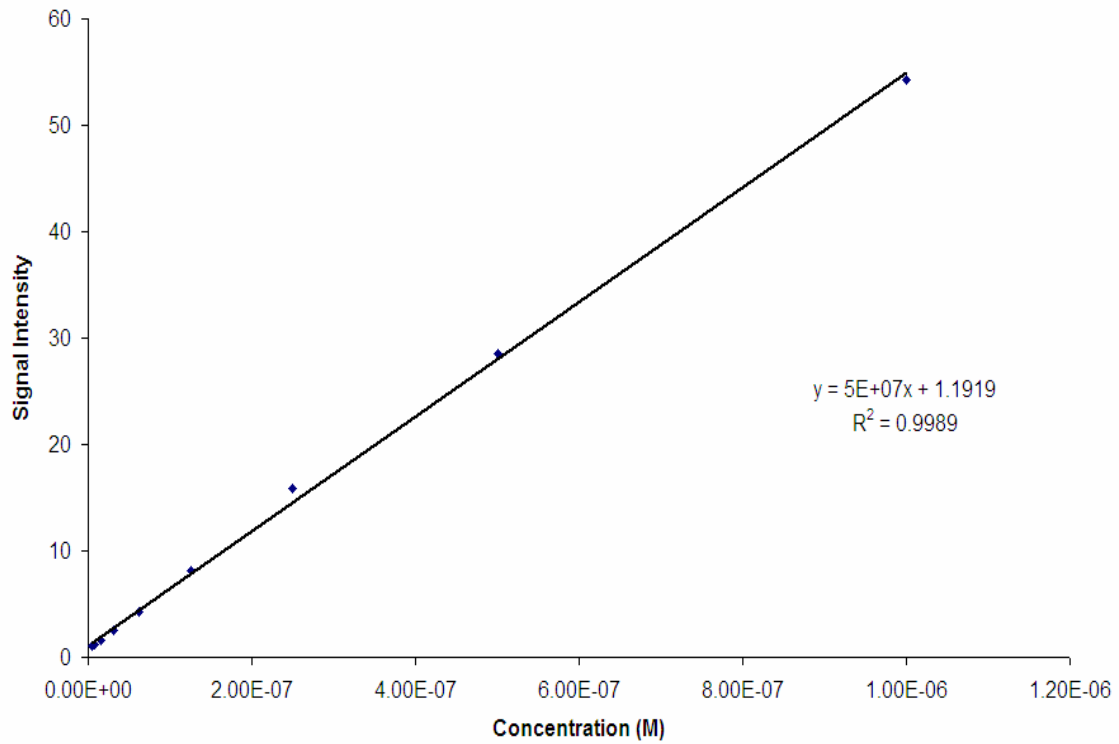
Energy Drinks	Riboflavin (Vitamin B <sub>2</sub> )	Niacin (Vitamin B <sub>3</sub> )	Pyridoxine (Vitamin B <sub>6</sub> )
Energy Venom	25.478	1.121	13.834
Red Rush	2.584*	1.060	14.655
Full Throttle	*****	0.877	10.743
Stacker 2	*****	1.0082	175.462
KORE	53.231	0.661	209.333
Mad Croc.	*****	*****	0.326

\*\*\*\*\* Exception-- the following drinks result was not good.

\* *UV-vis absorption point*

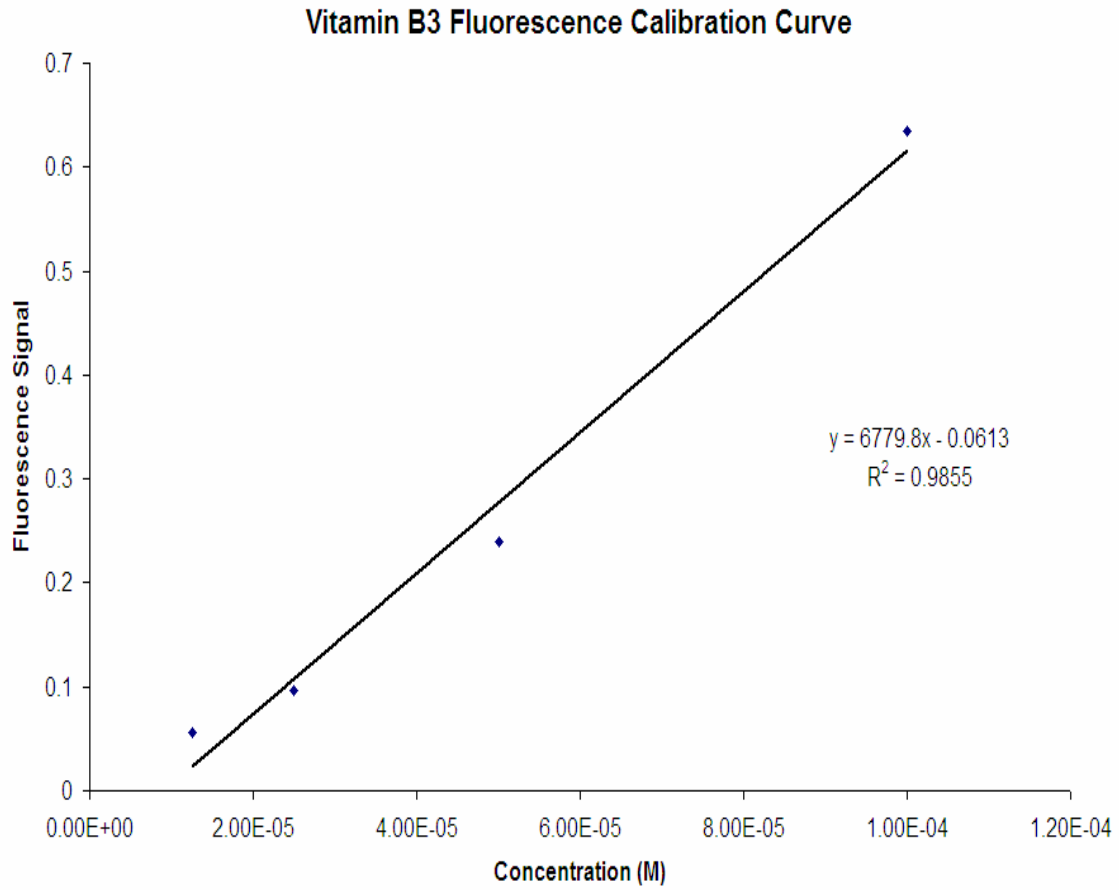
Below is the concentration and intensity signal and the fluorescence calibration curve of vitamin B<sub>2</sub>, B<sub>3</sub>, and B<sub>6</sub> respectfully, which are created by inserting the intensity points on the graph of the dilutions, in Microsoft Excel.

### Vitamin B2 Fluorescence Calibration Curve



Concentration	Signal
3.90E-09	1.018
7.80E-09	1.144
1.56E-08	1.639
3.13E-08	2.545
6.25E-08	4.291
1.25E-07	8.159
2.50E-07	15.837
5.00E-07	28.547
1.00E-06	54.312

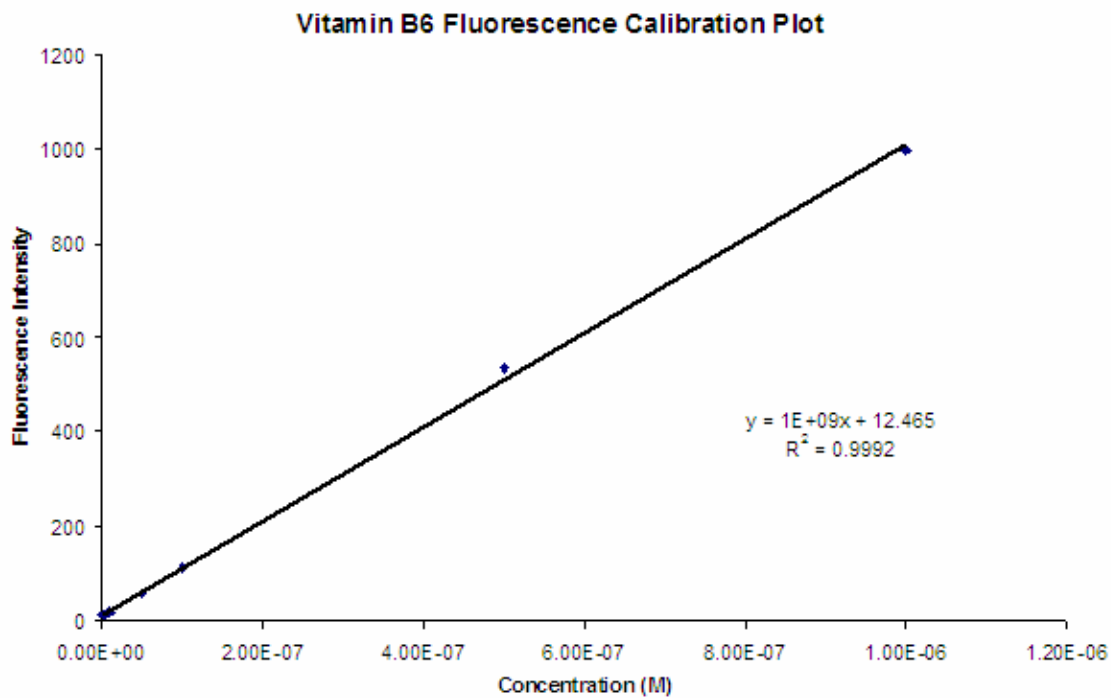
The concentration and intensity signal



Concentration	Fluorescence
1.25E-05	0.056
2.50E-05	0.096
5.00E-05	0.239
1.00E-04	0.635

The concentration and intensity signal





Concentration	Signal
1.00E-09	13.752
5.00E-09	14.195
1.00E-08	18.969
5.00E-08	57.185
1.00E-07	111.956
5.00E-07	533.488
1.00E-06	997.964

The concentration and intensity signal

Below are the results of the concentration of the vitamins in the KORE energy drinks, the others are in table #2.

**B<sub>2</sub>**KORE Energy Drink

1 ml into 100 ml

$$Y = 143.4X + 1.129$$

$$53.231 = 143.4X + 1.129$$

$$\underline{-1.129} \qquad \underline{-1.129}$$

$$\underline{52.102} = \underline{143.4X}$$

$$143.4 \quad 143.4$$

$$X = 3.63 \times 10^{-1} \text{ M} \times 100/1 = \mathbf{3.63 \times 10^1 \text{ M}}$$

**B<sub>3</sub>**KORE Energy Drink

1 ml into 10 ml

$$Y = 6779.8X - 0.0613$$

$$.661 = 6779.8X - 0.0613$$

$$\underline{+0.0613} \qquad \underline{+0.0613}$$

$$\underline{7.223 \times 10^{-1}} = 1.06 \times 10^{-4} \times 10 / 1 = \mathbf{1.06 \times 10^{-3} \text{ M}}$$

$$6779.8$$

**B<sub>6</sub>**KORE - 1 ml into 10 ml

$$Y = 1 \times 10^9 + 12.465$$

$$209.333 = 1 \times 10^9 + 12.465$$

$$\underline{-12.465} \qquad \underline{-12.465}$$

$$\frac{1.96 \times 10^2}{1 \times 10^9} = 1.96 \times 10^{-7} \times 10 / 1 = \mathbf{1.96 \times 10^{-6} \text{ M}}$$

Data and result for riboflavin tablets**Riboflavin (Vitamin B<sub>2</sub>) Tablets****Tablet A: Vitamin World Brand**

Tablets

Average weight of all 5 tablets: .68126g

1. Recorded weight: 0.6859g

2. Recorded weight: 0.6851g
3. Recorded weight: 0.6716g
4. Recorded weight: 0.6891g
5. Recorded weight: 0.6746g

Crush tablets and then weigh out .1 grams.

Recorded weight: .1041g

Add .1041g to a beaker with 1% glacial acetic acid, then to a 250 ml Volumetric Flask and dilute with the same solvent.

Calculations:

$$Y = 10504X + 0.0372$$

$$R = 0.9952$$

$$Y = mx + b$$

$$Y = 10504X + 0.0372$$

$$1.171 = 10504X + 0.0372$$

$$\begin{array}{r} 1.171 = 10504X + 0.0372 \\ -0.0372 = \quad -0.0372 \\ \hline 1.1338 = 10504X \\ 10504 \quad 10504 \end{array}$$

$$X = .00010794 = X$$

$$1.08 \times 10^{-4} \text{ M } (.250 \text{ L}) = 2.7 \times 10^{-5} \text{ moles}$$

$$2.7 \times 10^{-5} \text{ moles} \times \frac{376.36 \text{ g}}{\text{Mol}} = .0102 \text{ g}$$

$$\frac{.0102 \text{ g}}{.1137 \text{ g}} \times 100 = \underline{\underline{8.97 \%}}$$

Recommended Daily Allowance = .68126g

$$\frac{.1000 \text{ g}}{.68126 \text{ g}} \times 100 = \underline{\underline{14.7\%}}$$

$$\% \text{ error} = \frac{\text{experimental} - \text{actual}}{\text{Actual}} \times 100$$

$$= \frac{8.97 - 14.7}{14.7} \times 100 = \underline{\underline{-39\%}}$$

### **Riboflavin (Vitamin B<sub>2</sub>) Tablets**

#### **Tablet B: GNC Brand**

Tablets

Average weight of all 5 tablets: .41704 g

1. Recorded weight: .4148g
2. Recorded weight: .4173g
3. Recorded weight: .4167g

4. Recorded weight: .4162g
5. Recorded weight: .4202g

Crush tablets and then weigh out .1 grams.

Recorded weight: .1034g

Add .1041g to a beaker with 1% glacial acetic acid, then to a 250 ml Volumetric Flask and dilute with the same solvent.

Calculations:

$$Y = mx + b$$

$$Y = 10504X + .0376$$

$$1.626 = 10504X + .0376$$

$$\underline{-.0376} \qquad \underline{-.0376}$$

$$\underline{1.5884} = \underline{10504X}$$

$$10504 \qquad 10504$$

$$X = .001507021$$

$$1.50 \times 10^{-4} X (.250 \text{ L}) = .0000375$$

$$.0000375 \times \frac{376.36\text{g}}{\text{Mol}} = \underline{\underline{.014\text{g}}}$$

$$\underline{.014\text{g}} \times 100 = 13.7$$

$$.1041\text{g}$$

$$\frac{13.7\% - 14.7}{14.7} \times 100 = \underline{\underline{-6.802}}$$

The chart below displays the results of the vitamin's concentration we found in the following energy drinks.

**Table # 2**

<b>Energy Drinks</b>	<b>Riboflavin (Concentration)</b>	<b>Niacin (Concentration)</b>	<b>Pyridoxine (Concentration)</b>

Energy Venom	21.55 ppm *	$3.48 \times 10^{-4}$ M	7.11 ppm
Red Rush	9.93 ppm	$1.65 \times 10^{-3}$ M	1.77 ppm
Full Throttle	*****	$2.76 \times 10^{-4}$ M	*****
Stacker 2	*****	$1.57 \times 10^{-3}$ M	$1.62 \times 10^{-6}$ M
KORE	$3.63 \times 10^1$ M	$1.06 \times 10^{-3}$ M	$1.96 \times 10^{-6}$ M
Mad Croc.	*****	$5.71 \times 10^{-4}$ M	*****

\*\*\*\*\* Exception-- the following drinks result was not good.

\* *UV-vis absorption point*

## Conclusion

By doing the following experiment, we found out the concentration of Riboflavin, Niacin, and Pyridoxine in Energy Venom, Full Throttle, Mad Croc., KORE, Stacker 2, and Red Rush. All these drinks contain different concentration of each of the vitamins, some in very high amounts and some in very small amounts, making it hard to detect. One such result was riboflavin concentration in Stacker 2, and also vitamin B<sub>12</sub> had a very low concentration in most of the drinks we analyzed, making it very hard to detect, so we didn't use it.

We also found out the amount of riboflavin in the two riboflavin tablets that we analyzed, which are shown in the result. From the results we got, these vitamin sources do give us the recommended daily value of the supplement we need, some in different amounts.

## References

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- Vitamin B Information  
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