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Calculation of Effective Substance for Hyper Blood Pressure Using Matlab & Newton's Finite Method

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Authors' contributions

This work was carried out in collaboration between the two authors. Author ARARAG collected data, and wrote the first draft of the manuscript. Author MAAHA managed the analyses of the study, and the literature searches. Both authors read and approved the final manuscript.

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Abstract

This research aims at using the Newton's finite forward differences interpolation and Matlab program to analyze the data of effective substance for hyper blood pressure.
The researchers followed applied mathematical methods due to its suitability for such researches, namely Newtons' finite method and Matlab. We found the relationship between the construction of effective substance and time under fixed humidity and temperature, which changes the degree of concentration of effective substance; and also can predicts the degree of concentration inside or outside the interval. Then we reached to analyzing the data by using Matlab, which helps in explaining the required aims of the study easily and effectively.

Keywords: Effective substance (Amlodipine tablets etc…); hyper blood pressure; Matlab program; Newton's finite method.

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1 Introduction

In this paper statistical data will be analyzed using Newton's finite Method and Matlab program.

As it is well known, Matlab is a high-performance language for technical computing.It integrates computation, visualization, and programming in an easy-to-use environment, where problems and solutions are expressed in familiar mathematical notation.

The name Matlab stands for Matrix Laboratory [1].

Statistical data of Amlodipine 5 mg tablets state in period (26\10\2015 –26\ 10\2016) are used in this study, the relation between the amount of effective substance for hyper blood pressure as a dependent variable(y) and the time as an independent variable(x).

Over the past decade, increased BP variability is an independent predict for a higher risk of CVE.

Among the major groups of antihypertensive drugs, there are calcium antagonists, mainly amlodipine, which has the greatest potential to reduce BP variability.

Thus, calcium antagonists can be considered as first-line drugs for patients with high BP variability [2].

Amlodipine tablets contain the active substance amlodipine mesilate monohydrate.

Amlodipine belongs to a group of medicines called calcium antagonists, it is used to treat high blood pressure (hypertension) [3].

Then using Newton’s finite Method and Matlab program we present and display results.

The importance of this research is due to the fact that,human health is affected by hyper blood pressure which depends on effective substances.

2 Doses

Use alone or in combination with other antihypertensive agents to treat hypertension.

Doses 5mg to 10 mg according to severity of hypertension and control of disease.

Doses higher than 5 mg not been studied in pediatric patients, the dosage should be adjusted according to patient response. In general titration should proceed over 7 to 14 days, if clinically warranted titration may precede more rapidly provided the patient is assessed frequently [4].

Using effective substances in curing BP may develop some side effects.

The patient should check with his doctor immediately if any of these side effects occur when taking Amlodipine like swelling of the ankles or feet. Some of these effects are less common, such as difficult or labored breathing, dizziness, fast irregular, pounding, or racing heartbeat or pulse, feeling of warmth, redness of the face, neck, arms, and occasionally, upper chest shortness of breath, tightness in the chest, wheezing.

Also some minor side effects may be remarked with amlodipine and this may not need medical attention. As the patient’s body adjusts to the medicine during treatment these side effects may go away [5].

Drug Concentration: Amlodipine 5mg Tablet:

Temperature30±2% **Humidity 65±5%**

Table 1. Drug Concentration .[6]

26/10/2015	26/1/2016	26/4/2016	26/7/2015	26/10/2016
0^{th}.Month	3^{rd}. Month	6^{th}.Month	9^{th}.Month	12^{th}. Month
100.7%	100.6%	100.3%	99.7%	99.6%

3 Methodology: (Newton's Finite Method and Matlab Program)

3.1 Newton's finite method

As it is known, solving mathematical equations is an important requirement for various branches of science. Numerical analysis explores the techniques that give approximate solutions to such problems with the desired accuracy [7].

Numerical analysis is concerned with the mathematical derivation, description and analysis of methods obtaining numerical solutions of mathematical problems we shall be interested in constructive methods in mathematics.

These are methods which show how to construct solutions of mathematical problem [8,9,10,11].

The process of finding the curve passing through the points

$$(x_0, y_0), (x_1, y_1), \quad \dots, (x_n, y_n)$$

is called an interpolation and the curve obtained is called interpolating curve.

Interpolating polynomial passing through the given set of points is unique.

Let $x_0, x_1, \dots, x_n$ be given set of observations and $y = f(x)$ be the given function, then the method to find $f(x_m)\ \forall x_0 \leq x_m \leq x_n$ is called as an interpolation.

If x_m is not in the range of x_0 and x_n, then the method to find x_m is called extrapolation [12].

The process of finding the value of *y* for some value of *x* outside the given range is called extrapolation [13].

3.2 Finite differences methods and finite differences operators

Finite differences method are said to be global method since they simultaneously produce a solution over the entire interval [13,9].

For a function $y = f(x)$, it is given that $y_0, y_1, \dots, y_n$ are the values of the variable y corresponding to the equidistant arguments $x_0, x_1, \dots, x_n$.

Where $x_1 = x_0 + h,\ x_2 = x_0 + 2h,\ \dots, x_n = x_0 + nh$. [14]

In this case, even though Lagrange and divided differences interpolation polynomials can be used for interpolation, some simpler interpolation formulas can be derived.

For this, we have to be familiar with some finite differences operators and finite differences, which were introduced by Sir Isaac Newton.

Finite differences deal with the changes that take place in the value of a function $f(x)$ due to finite changes in x.

Finite differences operators include, forward differences operator, backward differences operator, shift operator, central differences operator and mean operator [7].

3.3 Forward difference operator (Δ)

For the values $y_0, y_1, \ldots, y_n$ of a function $y = f(x)$, for the equidistant values $x_0, x_1, \ldots, x_n$. where

$$x_1 = x_0 + h\,,\; x_2 = x_0 + 2h\,, \quad \ldots, x_n = x_0 + nh \tag{3.1}$$

The forward differences operator Δ is defined on the function $f(x)$ as

$$\Delta f(x) = f(x_1 + h) - f(x_1) = f(x_{i+1}) - f(x_i) \tag{3.2}$$

That is $\Delta y = y_{i+1} - y_i$

Then in particular

$$\Delta f(x_0) = f(x_0 + h) - f(x_0) = f(x_1) - f(x_0) \tag{3.3}$$

$$\Rightarrow \Delta y_0 = y_1 - y_0$$

$$\Delta f(x_1) = f(x_1 + h) - f(x_1) = f(x_2) - f(x_1) \tag{3.4}$$

$$\Rightarrow \Delta y_1 = y_2 - y_1$$

etc.,

$\Delta y_0, \Delta y_1, \ldots, \Delta y_i, \ldots$ Are known as the first forward differences

The second forward differences are defined as,

$$\Delta^2 f(x_i) = \Delta[\Delta f(x_i)] = \Delta[f(x_i + h) - f(x_i)] = \Delta f(x_i + h) - \Delta f(x_i)$$

$$= f(x_i + 2h) - f(x_i + h) - [f(x_i + h) - f(x_i)]$$

$$= f(x_i + 2h) - 2\, f(x_i + h) + f(x_i) \tag{3.5}$$

$$= y_{i+2} - 2\, y_{i+1} + y_i$$

In particular, $\Delta^2 f(x_0) = y_2 - 2y_1 + y_0 or$

$$\Delta^2 y_0 = y_2 - 2y_1 + y_0$$

The third forward differences is,

$$\Delta^3 f(x_i) = \Delta\left[\Delta^2 f(x_i)\right] = \Delta\left[f(x_i + 2h) - 2\, f(x_i + h) + f(x_i)\right] = y_{i+3} - 3y_{i+2} + 3\, y_{i+1} - y_i \tag{3.6}$$

In particular, $\Delta^3 f(x_0) = y_3 - 3y_2 + 3y_1 - y_0$ *or*

$$\Delta^3 y_0 = y_3 - 3y_2 + 3y_1 - y_0$$

In general the n^{th} forward differences,

$$\Delta^n f(x_i) = \Delta^{n-1} f(x_i + h) - \Delta^{n-1} f(x_i) \tag{3.7}$$

The differences Δy_0, $\Delta^2 y_0$, $\Delta^3 y_0$, are called the leading differences [7].

There are other ways to derive the same finite differences approximations.

One way is to approximate the function $u(x)$ by some polynomial $p(x)$ and then use $p_{n(x)}$ as an approximation to $u_{n(x)}$.

If we determine the polynomial by interpolating u at an appropriate set of points, then we obtain the same finite differences methods as above [13].

Forward differences can be written in tabular form as follows:

Table 2. Forward Differences

x	y	Δy	$\Delta^2 y$	$\Delta^3 y$
x_0	$y_0 = f(x_0)$			
		$\Delta y_0 = y_1 - y_0$		
x_1	$y_1 = f(x_1)$		$\Delta^2 y_0 = \Delta y_1 - \Delta y_0$	
		$\Delta y_1 = y_2 - y_1$		$\Delta^3 y_0 = \Delta^2 y_1 - \Delta^2 y_0$
x_2	$y_2 = f(x_2)$		$\Delta^2 y_1 = \Delta y_2 - \Delta y_1$	
		$\Delta y_2 = y_3 - y_2$		
x_3	$y_3 = f(x_3)$			

3.4 Newton's forward differences interpolation formula

Using Newton's forward differences interpolation formula, we find the n degree polynomial P_n which approximates the function *f(x)* in such a way that P_n and f agrees at $n+1$ equally spaced x values, so that

$$P_n(x_0) = f_0, \quad P_n(x_1) = f_1, \dots P_n(x_n) = f_n$$

Where $f_0 = f(x_0)$, $f_1 = f(x_1), \dots f_n = f(x_n)$ are

the values of f in the table.

Newton's Forward Differences Interpolation Formula:

$$f(x) = P_n(x) = f_0 + r\Delta f_o + \frac{r(r-1)}{2!}\Delta^{2f_o} + \cdots$$

$$+ \frac{r(r-1)\dots(r-n+1)}{n!}\Delta^n f_o,$$

where $x = x_0 + rh$, $r = \frac{x - x_0}{h}$, $0 \le r \le n$ [7]. (4.1)

3.5 Calculation using Newton's finite method

Using table No.(1) of drug concentration for Amlodipine 5mg tablets in temperature 30±2% and humidity 65±5%, and using Newton's forward differences interpolation formula to find $f(x)$, and evaluate it while $x = 15, 18, 21, 24$.

Now the Newton's forward differences interpolation formula is:

$$f(x) = P_n(x) = f_0 + r\Delta f_o + \frac{r(r-1)}{2!}\Delta^{2f_o} + \cdots$$

$$+\frac{r(r-1)\ldots(r-n+1)}{n!}\Delta^n f_o\,,$$

where $x = x_0 + rh, \quad r = \frac{x-x_0}{h}\,, \quad 0 \le r \le n$ (4.2)

Now $x_0 = 0, x_1 = 3, \quad h = x_1 - x_0 = 3 - 0 = 3$

$$r = \frac{(x - x_0\,)}{h} = \frac{(x-0)}{3} = \frac{x}{3}$$

$\therefore h = 3$ and $r = \frac{x}{3}$

Forward differences can be written in tabular form as follows:

Table 3. Solution of forward differences

$\boldsymbol{x}$	$\boldsymbol{f(x)}$	$\Delta\boldsymbol{f}$	$\Delta^{2}\boldsymbol{f}$	$\Delta^{3}\boldsymbol{f}$	$\Delta^{4}\boldsymbol{f}$
0	100.7				
		-0.1			
3	100.6		-0.2		
		-0.3		-0.1	
6	100.3		-0.3		0.9
		-0.6		0.8	
9	99.7		0.5		
		-0.1			
12	99.6				

$$f_0 = 100.7, \Delta f_0 = -0.1, \qquad \Delta^2 f_0 = -0.2,$$

$$\Delta^3 f_0 = -\,0.1, \qquad \Delta^4 f_0 = 0.9$$

Substituting these values in the Newton's forward differences interpolation formula $n = 4$, we obtain

$$f(x) = P_4(x) = f_0 + r\Delta f_o + \frac{r(r-1)}{2!}\Delta^2 f_o$$

$$+\frac{r(r-1)(r-2)}{3!}\Delta^3 f_o + \frac{r(r-1)(r-2)(r-3)}{4!}\Delta^4 f_o \qquad (4.3)$$

So that $f(x) \approx 100.7 + \frac{x}{3}(-0.1) + \frac{\frac{x}{3}\left(\frac{x}{3}-1\right)}{2!}(-0.2) +$

$$\frac{\frac{x}{3}\left(\frac{x}{3}-1\right)\left(\frac{x}{3}-2\right)}{3!}(-0.)+\frac{\frac{x}{3}\left(\frac{x}{3}-1\right)\left(\frac{x}{3}-2\right)\left(\frac{x}{3}-3\right)}{4!}(0.9) \quad (4.4)$$

$$f(x) \approx 100.7-\frac{x}{30}-\frac{x^2-3x}{90}-\frac{x^3-9x^2+18x}{1620}$$

$$+\frac{x^4-18x^3+99x^2-162x}{2160} \quad (4.5)$$

$$\therefore f(x)=\frac{x^4}{2160}-\frac{87}{9720}x^3+\frac{29}{720}x^2-\frac{93}{1080}x+100.7 \quad (4.6)$$

$\boldsymbol{x=15}$

$$\therefore f(15)=\frac{15^4}{2160}-\frac{87}{9720}(15^3)+\frac{29}{720}(15^2)-\frac{93}{1080}\,(15)+100.7$$

$$=\frac{50625}{2160}-\frac{87}{9720}(3375)+\frac{29}{720}(225)-\frac{93}{1080}(15)+100.7 \quad =101.7 \quad (4.7)$$

$\boldsymbol{x=18}$

$$\therefore f(18)=\frac{18^4}{2160}-\frac{87}{9720}(18^3)+\frac{29}{720}(18^2)-\frac{93}{1080}\,(18)+100.7$$

$$=\frac{104976}{2160}-\frac{87}{9720}(5832)+\frac{29}{720}(324)-\frac{93}{1080}(18)+100.7$$

$$=108.6 \quad (4.8)$$

$\boldsymbol{x=21}$

$$\therefore f(21)=\frac{21^4}{2160}-\frac{87}{9720}(21^3)+\frac{29}{720}(21^2)-\frac{93}{1080}\,(21)+100.7$$

$$=\frac{194481}{2160}-\frac{87}{9720}(9261)+\frac{29}{720}(441)-\frac{93}{1080}(21)+100.7$$

$$=123.8 \quad (4.8)$$

$\boldsymbol{x=24}$

$$\therefore f(24)=\frac{24^4}{2160}-\frac{87}{9720}(24^3)+\frac{29}{720}(24^2)-\frac{93}{1080}\,(24)+100.7$$

$$=\frac{3311776}{2160}-\frac{87}{9720}(13824)+\frac{29}{720}(576)-\frac{93}{1080}(24)+100.7$$

$$=151.7 \quad (4.9)$$

Finding $f(x)$ at $x=15, 18, 21, 24$ ...is called extrapolation.

This figure shows the degree of concentration according to time from (26/10/2015) to (26/10/2017):

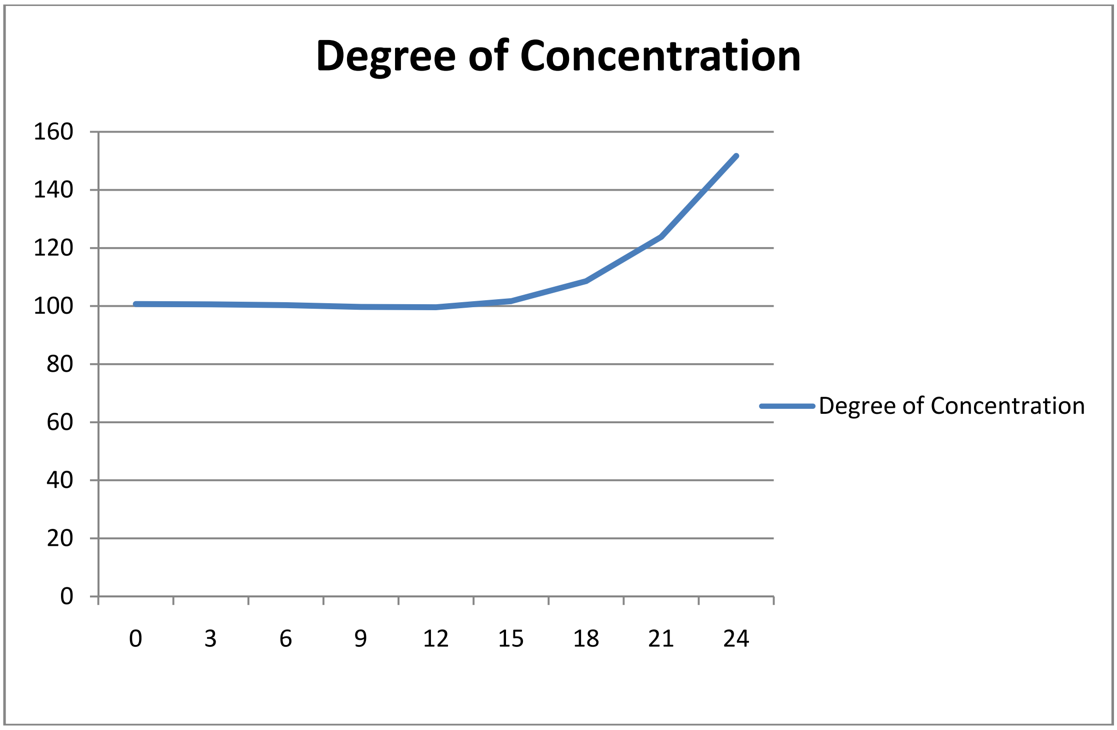

Fig. 1. Degree of Concentration using Newton's method

4 Matlab Program

Matlab, which stands for Matrix Laboratory, is a software package developed by Math Works Inc. to facilitate numerical computations as well as some symbolic manipulation. [15],[16]

Matlab is a tool for mathematical (technical) calculations.

First, it can be used as scientific calculator.

Next, it allows you to plot or visualize data in many different ways, perform matrix algebra, work with polynomials or integrate functions.

In the end, Matlab can also be treated as a user-friendly programming language, which gives the possibility to handle mathematical calculations in an easy way.

In summary, as a computing/programming environment, Matlab is especially designed to work with data sets as a whole such as vectors, matrices and images [17].

This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non interactive language such as C or Fortran [18].

Matlab has four flow control and/or branching instructions: for loops, while loops, if-else branching tests, and switch branching tests.

All of these instructions end with an end statement, and it is frequently difficult to determine the extent of these instructions.

Thus, it is very important to use indentation to indicate the structure of a code, as we do in the remainder of this tutorial.?

This greatly increases the readability of the code of human beings[19,1]

5 Analysis of Data Using Matlab

5.1 Newton’s forward differences formula in matlab program

Finding $f(x)$ $while$ $x = 15, 18, 21, 24$.

%change the value of (*xp*=15,18,21, 24) inside the program

```
x = [0 3 6 9 12];
fx = [100.7 100.6 100.3 99.7 99.6];
dt = zeros(5,6);   % function
for i=1:5  % for loop
dt(i,1)=x(i);
dt(i,2)=fx(i); % calling function
end
n=4; % number of iteration
for j=3:6
for i=1:n
dt(i,j)= dt(i+1,j-1)-dt(i,j-1);
end
 n=n-1;
end
h=x(2)-x(1); % finding the value of h
xp=15; % defining the value of x
for i=1:5
q=(xp-x(i))/h;
end
l = xp-(q*h);
for i=1:5
if(l==x(i))
r=i;
end
end
% calculating different value of y
f0=fx(r);
f01=dt((r-1),3);
f02=dt((r-2),4);
f03=dt((r-3),5);
f04=dt((r-4),6);
fp=(f0)+((q*f01)+(q*(q+1)*f02)/(2))+((q*(q+1)*(q+2)*f03)/(6))+((q*(q+1)*(q+2)*(q+3)*f04)/(24));[20]
```

Table 4. Program Result

26/1/2017	26/4/2017	26/7/2017	26/10/2017
15^{th}Month	18^{th}Month	21^{th}Month	24^{th}Month
101.7%	108.6%	123.8%	151.7%

5.2 Program

To find figure that shows the degree of concentration according to time from (26/10/2015) to (26/10/2017):

```
x=[0 3 6 9 12 15 18 21 24];
y=[100.7 100.6 100.3 99.7 99.6 101.7 108.6 123.8 151.7];
plot(x,y);
xlabel('The Time');
ylabel('The Concentration');
title('Finite Differences Method Using Matlab');
```

Degree of Concentration using Matlab:

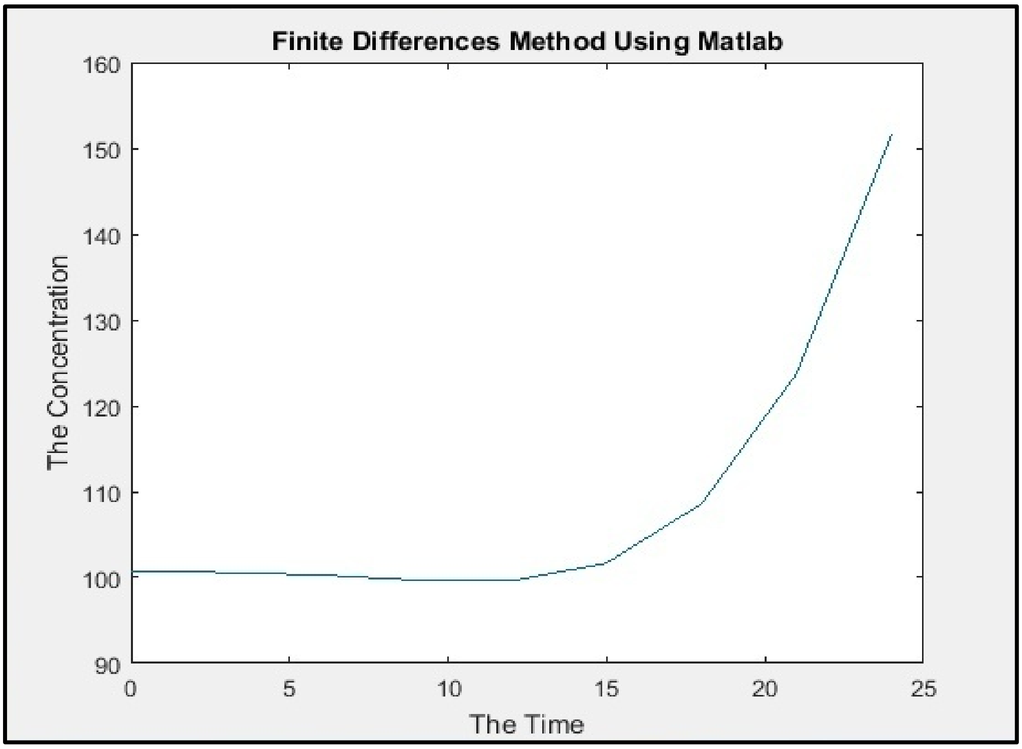

Fig. 2. Degree of Concentration using Matlab

6 Results

After calculating data, the finite differences method is accurate but analyzing by using matlab is more quick and easy.

The results show that the concentration of effective substance in period from (26/1/2017) to (26/10/2017) in Table 4, which called extrapolation.

Concentration changes according to time which is shown in Fig. 1 and Fig. 2.

7 Conclusion

The research presents computers processing system for Newton's finite differences interpolation formula using Matlab program for analyzing the data of effective substance of hyper blood pressure.

All this data passed through code that designed by Matlab program for analysis and evaluated obtained plot function for each month, and concentration for selected months.

Competing Interests

Authors have declared that no competing interests exist.

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