A Healthy Breastfeeding Environment: Application of Graph Colouring on Infant Milk 0-6 Months

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Abstract. Infants aged 0-6 months require exclusive breastfeeding, because the baby's digestion has not been able to obtain additional food. But not all mothers can breastfeed because of several factors, therefore formula milk is also very needed in infants who can not receive breast milk as a substitute. In the selection of baby milk there are many methods that can be done, but in this study using graph coloring to obtain the appropriate infant milk. Based on result of research from 22 data of baby born normal and baby birth weight according to standard use 8 kinds of milk, after done graph coloring process hence obtained result that for infant recommended 1 type of milk there are 4 baby, 2 type of milk there is 1 baby, 3 kind of milk there are 3 babies, 4 types of milk there are 2 babies, 5 types of milk there are 2 babies, 6 types of milk there are 4 babies, and 7 types of milk there are 6 babies.

Keyword: *ASI, Graph Colouring, Infant Milk*.

1. Introduction

In building the nation, human quality improvement should start as early as possible since the baby. The provision of breast milk (breast milk) is one of the factors that plays an important role in improving human quality [4]. Provision of nutrition in infants should [1] sufficient since still in the womb. Once the baby is born, it is endeavored to exclusively breastfeed. Infants aged 0-6 months need exclusive breastfeeding, because the baby's digestion has not been able to obtain supplementary food. Breastfeeding maximally is an important activity to prepare the next generation of the nation, because every baby needs nutritional and nutritional intake for the sake of survival. But not all mothers can breastfeed because of several factors, therefore formula milk is also very needed in infants who can not receive breast milk as a substitute of breast milk substitute.

In the selection of baby milk there are many methods that can be done, but in this study using graph coloring to obtain the appropriate infant milk. The research using graph coloring was done by Tasari (2012) which applied the application of graph coloring on lecturing scheduling in mathematics education program unwidha Klaten. While Handayani et al (2016) apply a welch powell algorithm with graph coloring on the scheduling of high school subjects.

The research on infant milk 0-6 months of age is done by Fitri et al (2014) about the relationship of breastfeeding by growing the development of a 6-month-old infant at the Nanggalo Community Health Center which resulted in the conclusion that there is a significant relationship between breastfeeding and infant development. Candriasih (2010) exclusive breastfeeding in infants aged 0-6

months in Tambu District Health Center of Donggala Regency resulted in the conclusion that there is no correlation between knowledge, education, occupation and attitude with exclusive breastfeeding in infants aged 0-6 months in the work area Puskesmas Tambu. While Oktiyani et al (2015) examined the relationship of exclusive breastfeeding to the development of infants aged 0-6 months in the work area of Padangsari Puskesmas Semarang which resulted in the conclusion that there is a relationship between exclusive breastfeeding on language / cognitive development of infants aged 0-6 months. Based on this, no research has been done on the application of graph coloring to infants aged 0-6 months, hence the researcher is interested to do more research about the application of graph coloring on infant milk 0-6 months appropriate as a substitute for mother's milk that is not can provide breast milk or infants who can not receive breast milk intake.

2. Preliminary Concepts and Definitions

This section presents briefly the basic concept related to infants aged 0-6 months, formula milk and implementation of graph coloring.

2.1. Infants Aged 0-6 Months

Infants aged 0-6 months as recommended by World Health Organization (WHO) in 2001 need only breast milk alone without any liquid or solid foods called exclusive breastfeeding [5]. In infants aged 0-6 months exclusive breastfeeding is the best food for babies because it contains all the nutrients in the number and ideal composition needed by the baby to grow and develop optimally [11].

2.2. Birth of the Baby

The role of midwives in performing normal newborn care includes resuscitation, hypothermia inhibition, early breastfeeding initiation, vitamin K1 injections, neonatal newborn care (0-28 days) and umbilical cord care. Newborns are careful, fast, precise, safe, and clean. It is an essential part of the newborn. Much of the delivery process is focused on the mother, but in connection with the process of outcome of the pregnancy (baby). So the management of new labor is said to be successful if the mother and the baby are in optimal condition, so that other than the mother of the born baby must also be in good health [7].

Babies with cesarean section surgery are designated for certain medical indications, which are divided into indications for the mother and indications for the infant. Cesarean delivery should be understood as an alternative to labor when labor is normal no longer possible. Although 90% of deliveries fall into the normal category or without complications of labor, but in case of complications the treatment always adheres to the priority of maternal and infant safety. This cesarean section surgery is the last choice of labor after consideration of vaginal delivery methods not feasible [9].

All pregnant women have a risk of birth defects, regardless of age, race, income or occupancy status. Congenital malformations or birth defects are a structural abnormality, behavioral abnormality, functional abnormality, and metabolic abnormalities present in infants at birth, regardless of whether the disorder is caused by genetic or other factors but has a permanent effect. Patients with severe or major survival abnormalities, will be affected physically, mentally, or socially and have an increased risk of being unhealthy to various health disorders. Birth defects can be categorized by cause, due to mutations of a single gene and specific inheritance patterns (about 25%), known environmental causes (about 8%), structural changes or chromosome number (about 7%) and unknown causes 60%). Another catagore is a combination of two or more of the causes known to cause multiple congenitals [8].

2.3. Maternal Milk

Maternal Milk (ASI) is the best food a mother can give her baby, since the comprements in breast milk are suitable for infant growth and development at all times [1]. Breastfeeding without other foodstuffs can meet the growing needs of about six months of age through exclusive breastfeeding. Exclusive

breastfeeding is a baby receiving only breast milk from a mother or caregiver requested to breastfeed from the mother, without adding fluids or other solid foods. Babies who are breastfed exclusively will experience optimal growth and development. Optimal growth can be seen from the addition of weight, height or head circumference, while the optimal development can be seen from the increase in abusive motor skills, psychomotor and language [10].

2.4. Formula Milk

Some of the conditions experienced by mothers, such as breast milk do not come out, breast milk out but only a little, the habits of working mothers and weight reasons babies fatter, which causes mothers to switch from breast milk to formula. While the use of infant formula that is not correct or inappropriate can cause health hazards, especially diarrhea. Formula milk is a good medium for bacterial growth, so contamination is easy to occur especially if preparation and administration are less attention to antiseptic. However, when viewed from the charts of weight charts in the KMS book, infants who were fed formula sooner had more weight gain than exclusively breastfed babies. In addition, infants fed formula are also more likely to experience pain such as diarrhea, fever, and cough colds. Therefore, exclusive breastfeeding and infant formula greatly affect the baby's nutritional status [3].

2.5. Graph Theory

Graph theory is the subject of language that is old age but has a lot of applied to date. The graph is used to represent discrete objects and relationships between them. The visual representation of a graph is to declare objects with nodes, nodes, spheres, dots, or vertices, while relations between objects are expressed by lines or edges. One application related to graph is graph coloring [12]. The definition of a graph itself is as a set of sets (V, E) in terms of:
- V = the non-empty set of vertices (vertices or nodes) and
- E = a set of sides (edges or arcs) connecting a pair of vertices.

2.6. Graph Colouring

Graph coloring is the process of labeling each vertex in a graph with a specific label (color) so that no two adjacent or conflicting nodes have the same color. Side by side or contradict means there is a segment connecting the two vertices. There are 3 kinds of graph dyeing [12]:
- Vertex coloring (vertex coloring), is a color or label on each node so there are no neighboring 2 vertices that have the same color.
- Edge coloring, is a coloring on each side of the graph so that the corresponding sides do not have the same color.
- Coloring the region (coloring region), is the color giving on each region on the graph so that no adjacent areas that have the same color. The minimum number of colors that can be used to color graph is expressed by chromatic numbers, which is denoted by $\chi(G)$. The algorithm that can be used to obtain the chromatic number of a graph is the Welch-Powell algorithm.

The Welch-Powell algorithm is one of the graph coloring algorithms that perform staining based on the highest degree of the dots or called Largest Degree Ordering (LDO). The Welch-Powell algorithm can be used to color a graph G efficiently. Welch-Powell algorithm is suitable for small order graphs. Here's the algorithm [2]:
- Sort the dots of G in decreasing degrees (this sequence may not be unique because some points may be of the same degree).
- Use one color to color the first point (which has the highest degree) and other points (in sequential order) not adjacent to the first point.
- Start again with the next highest degree of degree in the un-colored sequence list and repeat the dye staining process using the second color.

- Repeat the use of colors until all the dots have been colored.

The dyeing of the graph G is given as much as n colors at a point so that two interconnected points are not directly colored. Side coloring on graph G is the giving of n colors on the sides so that the two directly interconnected sides are not given the same color. The smallest number n so that graph G can be colored by the way is called the chromatic number. The point chromatic number written $\chi(G)$ and side chromatic numbers are written $\div'(G)$.

3. Research Method

Infants at 0-6 months should receive full intake of breast milk from their mothers, but if breast milk from their mothers is inadequate or unable to breastfeed or the baby when breastfed is still lacking or there are abnormalities, it is necessary to be assisted with special formula milk for age baby from 0-6 months. When the birth process, there are babies who are born normal (no defects) and there are also babies born disabled. In this study more devoted to normal-born infants with different birth weight babies, because there are infants who need special attention for babies born under or over standard births. As for babies born with a standard weight that is in the range 2500-4000 grams, while under 2500 grams then the baby is born below the standard (BBLR) and for birth above 4000 grams then the baby is above the standard.

In this study, the data used are taken from several regions in Indonesia. The data amounted to 26 data with female infants as many as 8 people from 2015-present, while the remaining boys. The babies are born normal and standard. As for all kinds of baby milk for 0-6 months of age in this study that can be recommended for babies of standard age there are 32 types of milk, but based on data obtained that have the same nutritional value then only used 8 types of milk, with variable information nutritional value which is used energy, protein, carbohydrates, fat. As for infant milk for low birth weight obtained and are on the market there are 2 types of milk. Take the X1 data and then do the calculation using graph coloring obtained the results in Figure 1.

Figure 1. Result of Graph Coloring Using X1 Data.
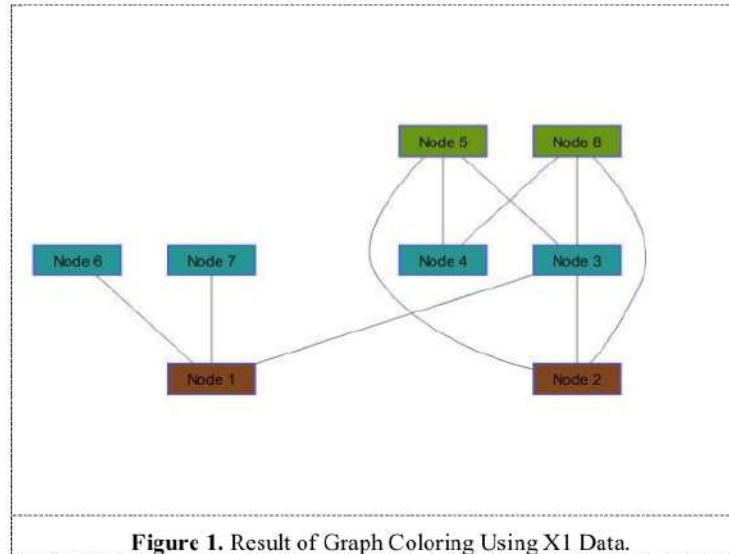
So that the results of the recap of the graph coloring in Figure 6 formed into the table can be seen in Table 1.

Table 1. Recap Results of the 1st Baby Data Graph Coloring

Type of Milk	Neighboring Point	Level
V1	V7, V3, V6	3
V2	V3, V8, V5	3
V3	V2, V8, V1, V5	4
V4	V5, V8	2
V5	V4, V2, V3	3
V6	V1	1
V7	V1	1
V8	V2, V3, V4	3

Then randomly calculated from the selection of 8 types of milk to each baby by simulated using matlab to obtain the results that can be seen in table 2.

Table 2. Result of the Random Selection of Infant Milk 0-6 Months

Baby (X)	V1	V2	V3	V4	V5	V6	V7	V8
X1	*	-	*	-	-	-	*	-
X2	-	-	*	*	*	-	*	-
X3	*	*	*	*	*	*	*	-
X4	-	-	*	-	-	*	-	*
X5	*	*	*	*	*	*	-	*
X6	*	-	*	*	*	*	*	*
X7	*	*	*	*	*	*	-	*
X8	-	-	-	*	*	*	-	-
X9	-	-	*	-	-	-	*	-
X10	*	*	*	*	-	*	*	*
X11	-	*	*	*	*	-	-	*
X12	*	*	*	-	*	*	*	*
X13	*	*	-	*	*	*	*	-
X14	-	-	*	*	*	*	*	*
X15	*	*	*	-	*	*	*	-
X16	*	-	-	-	-	-	-	-
X17	-	-	-	*	-	-	-	-
X18	-	*	-	*	-	*	-	*
X19	-	-	-	-	-	-	*	-
X20	-	-	-	-	*	-	-	-
X21	*	-	*	*	*	-	*	-
X22	-	*	*	*	*	-	*	*

4. Result and Discussion

4.1. Application of Graph Coloring

From table 1 it appears that there is a "*" sign indicating that the infant is recommended the type of milk V to-i, while the sign "-" meaning the baby is not recommended type of milk V to-i. Then from the results of table 1 is made graph coloring using graph coloring algorithm with a node that has the most colored side first, so the total results can be seen in figure 2.
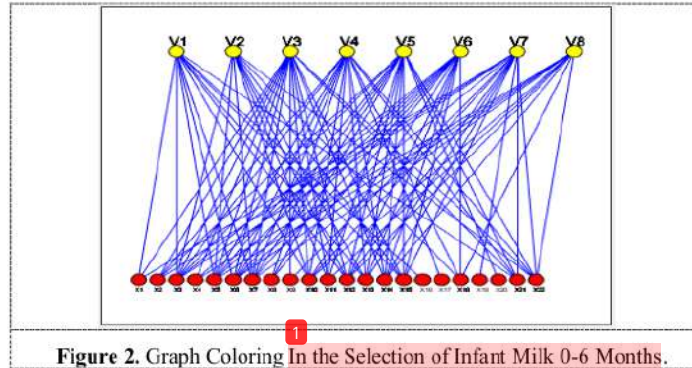

Figure 2. Graph Coloring In the Selection of Infant Milk 0-6 Months.

From figure 2 it can be seen that 2 colored staining with milk type (V) is colored yellow and baby (X) 0-6 months old is colored red. Because there are many, so separated each type of milk to be seen graph coloration that formed.
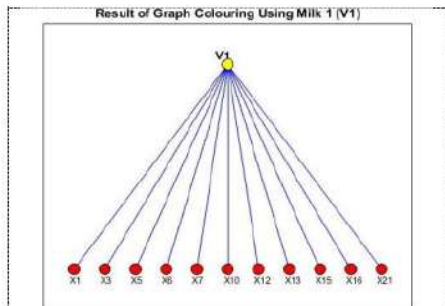
Figure 3. Result of Graph Coloring Using Milk 1 (V1).
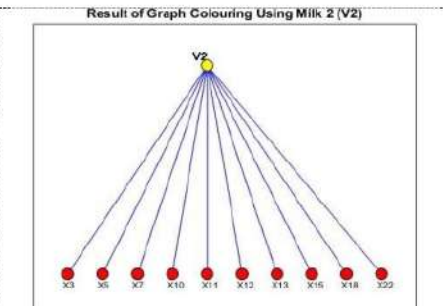
Figure 4. Result of Graph Coloring Using Milk 2 (V2).

Figure 3 is the result of the separation for the milk type 1 and figure 4 is the result of the separation for the milk type 2 from the total graph coloring in figure 1. From figure 3, there are approximately 11 infants which can be recommended in the milk type 1, meanwhile from figure 4 it is seen that there are about 10 infants that can be recommended in the milk type 2.
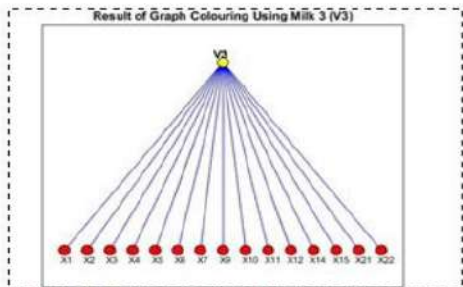
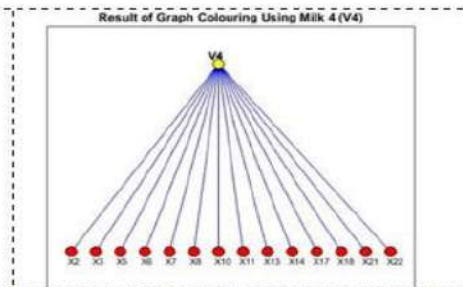**Figure 5.** Result of Graph Coloring Using Milk 3 (V3).

Figure 6. Result of Graph Coloring Using Milk 4 (V4).

Figure 5 is the result of the separation for the milk type 3 and figure 6 is the result of the separation for the milk type 4 from the total graph coloring in figure 1. From figure 5 it shows that there are about 15 infants that can be recommended in milk type 3, meanwhile from figure 6 it is seen that about 14 infants can be recommended in milk type 4.
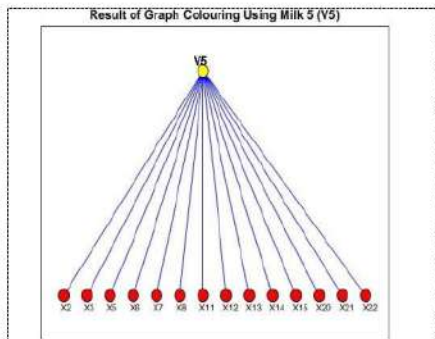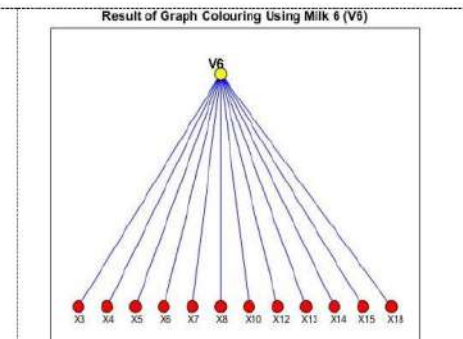

Figure 7. Result of Graph Coloring Using Milk 5 (V5).

Figure 8. Result of Graph Coloring Using Milk 6 (V6).

Figure 7 is the result of the separation for the milk type 5 and figure 8 is the result of the separation for the milk type 6 from the total graph coloring in figure 1. From figure 7 it shows that there are about 14 infants that can be recommended in milk type 5, meanwhile from figure 8, there are about 12 infants that can be recommended in the milk type 6.
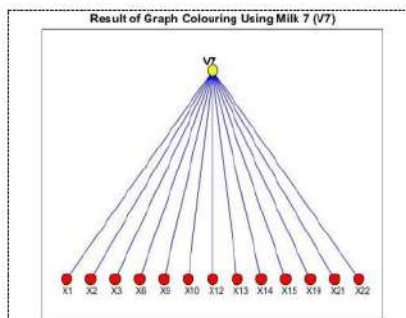

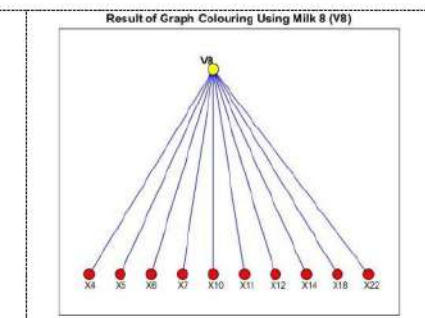**Figure 9.** Result of Graph Coloring Using Milk 7 (V7).

Figure 10. Result of Graph Coloring Using Milk 8 (V8).

Figure 9 is the result of the separation for the milk type 7 and figure 10 is the result of the separation for the milk type 8 of the total graph color in figure 1. From figure 9, there are about 13 infants which can be recommended in milk type 7, meanwhile from figure 10, there are approximately 10 infants which can be recommended in milk type 8.

4.2. Final Result

After finish, so it can be grouped the results of the coloring of each baby to all types of milk that can be recommended for the baby. The result we can take a look in table 3.

Table 3 Final Result From Total of Graph Colouring

Bayi (X)	Titik Tetangga	Derajat
X1	V3, V2, V8	3
X2	V2, V4, V5, V8	4
X3	V3, V7, V2, V4, V5, V6, V8	7
X4	V2, V6, V1	3
X5	V3, V7, V2, V4, V5, V6, V1	7
X6	V3, V2, V4, V5, V6, V8, V1	7
X7	V3, V7, V2, V4, V5, V6, V1	7
X8	V4, V5, V6	3
X9	V2, V8	2
X10	V3, V7, V2, V4, V6, V8, V1	7
X11	V7, V2, V4, V5, V1	5
X12	V3, V7, V2, V5, V6, V8, V1	7
X13	V3, V7, V4, V5, V6, V8	6
X14	V2, V4, V5, V6, V8, V1	6
X15	V3, V7, V2, V5, V6, V8	6
X16	V3	1
X17	V4	1
X18	V7, V4, V6, V1	4
X19	V8	1
X20	V5	1
X21	V3, V2, V4, V5, V8	5
X22	V7, V2, V4, V5, V8, V1	6

5. Conclusion

Praise The conclusions of this research is based on the 26 data baby, after done the process of dyeing graf obtained results that for the recommended baby 1 type of milk there are 4 babies, 2 types of milk there is 1 baby, 3 types of milk there are 3 babies, 4 types of milk there 2 babies, 5 types of milk there are 2 babies, 6 types of milk there are 4 babies, and 7 types of milk there are 6 babies.

For further research, more analysis of the existing variables is done by decision making using FMADM or other method by performing weighting to be chosen 1 type of milk that is appropriate to infants 0-6 months of age and added baby data (not only those born normal, but also those with disabilities, low birth weight and height and allergic infants) as well as nutritional value information (variables) plus.

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